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The King's Silver Jubilee.

THE twenty-fifth anniversary of the King's accession to the Throne was celebrated on Monday the 6th of this month with great rejoicing throughout the British Empire. In the official form of prayer and of thanksgiving prescribed for use on the auspicious occasion by the Metropolitan of the Province of India, there is a striking passage which comes nearest to the sentiments of the millions of King's loyal subjects and we reproduce it here :

"It is very meet, right and our bounden duty that we should give thanks to Thee, O Lord, Holy Father, Almighty, Everlasting God, for that Thou wast pleased as on this day to set Thy Servant, Our Sovereign Lord, King George, Emperor of India, upon His Throne and hast protected him in days of sickness and of health throughout his reign of five and twenty years. For the example of increasing service set by him and by our gracious Queen Mary ; for the strength and steadfastness bestowed on him and on the Nation in years of war and of manifold anxieties ; for the love and loyalty borne to him by a great family of peoples in all parts of the world, we laud and magnify Thy glorious name. We bless Thee for increase in the knowledge of Thy marvellous works, in care for those who suffer from sickness or the lack of work, in desire that all men everywhere may live in peace and enjoy the fruits of their labour. For these and all other Thy mercies vouchsafed to us, O Father Almighty, We yield Thee unfeigned thanks."

Pomp and pageantry are survivals of dim antiquity but they are the only means of expressing the affection and loyalty of the people to their Sovereign. They are ephemeral. The historian who chronicles the events of the first quarter of the twentieth century has to portray them uninfluenced by the magnificent popular demonstrations. His Majesty's reign is an eventful one. Unfortunately the history of the last twenty years is a record of unfulfilled ideals and frustrated achievement in the political, economic and social aspects of national life. It is no doubt true that progress has been made in many fields of human endeavour, but it has promoted neither general welfare nor happiness. The Great War which broke out in the early part of His Majesty's reign, dislocated every department of public life in a manner for which history scarcely furnishes a parallel, and from the consequences of which the combined effort of all the statesmen have not rescued the world.

Practically every civilised state passed through great and terrible experiences during the past twenty years, and international

jealousies and economic rivalries have befogged the ideals for which the War was fought. The uniform cheerfulness and the unobtrusive readiness with which His Majesty has endeavoured to contribute to the solution of the most outstanding post-war problems will form an illuminating chapter in the history of this period. It would be pessimistic to maintain that there has been no progress, but the results have not been commensurate with the possibilities of establishing peace and concord which still elude the grasp of the world's ablest statesmen. However, the King's Jubilee message, "I dedicate myself anew to your service for the years that may still be given me," ought to fill the hearts of nations with fresh hopes for the achievement of international goodwill and amity. Their attainment depends not on the length of our prayers, nor on the skill in diplomacy, but entirely on the measure of self-sacrifice and the breadth and kindliness of humanity which we bring to bear on the solution of the difficult and intricate problems which confront the League of Nations and International Conferences. We have to substitute the spirit of Christian humility for the language of patriotism in the settlement of world's affairs. The anniversary which was recently celebrated has a deeper significance for the British Commonwealth than a display of loyalty to the Crown: it is an invitation to the genius of the Empire to put forth fresh exertions in the international councils,

"Till each man find his own in all men's good,

And all men work in noble brotherhood," and for the achievement of this end, the King has offered his gracious co-operation in his broadcast message. The interest which foreign countries have shown in the celebration of the Silver Jubilee may be regarded as offering fresh hopes of international collaboration in reconstructing the economic fabric of the world.

In the whole history of civilisation, there is no more psychologically puzzling phenomenon than the situation in the year of the Silver Jubilee. All the nations as if by common consent have drifted from the path of peace, sanity and wisdom, and under the malign influence of the Political and Economic "Legion", they are precipitating down the Gadarene slopes to submergence. The Great War was fought to save civilisation, liberty and democracy; these ideals are smoke-screened by political passions and economic restrictions; the bitter lessons of militarism have only led the nations to sow

fresh Dragon teeth; the ideals of the church and the claims of common humanity have almost been forgotten in the transactions of international affairs. It is yet possible that the auspicious anniversary of the Silver Jubilee may be the occasion for the birth of a new and moving hope to cement international sympathy, confidence and friendship, without which the perplexing problems which now confront civilisation will finally overwhelm humanity, if they are not wisely handled to compass a higher unity and a broader synthesis. In the political and economic conflicts, we forget the essence of human nature, its scale of values, the meaning and purpose of social existence, its desires and aspirations.

The multiple contradictions of the present stage of civilisation must be due to the fact that while the progress of science has endowed man with almost fabulous powers for controlling his environment and refining his nature, it has in the sphere of thought apparently dissociated the human spirit from the world values in which inevitably it has its existence. Viewed from a superficial standpoint, science would appear to have come up against the meaning and purpose of human nature and this confusion has affected other fields of thought and activity so completely that further progress in the outer and inner life seems to be barred unless a bridge is thrown across the chasm which separates faith and action and ideals and practice. The increasing appreciation of the functions of science in civilisation may be hoped to remove such anomalies which generally arise from false emphasis on values and from treatment of incomplete or inaccurate premises as if they are whole and final. A great psychological event which has its roots in the heart of the nation has often deflected the current of public affairs, and the Silver Jubilee, which has stirred the imagination of the whole Empire, may, if its spirit is understood, perhaps prove to be the turning point of the fortunes of the greatly distracted and perplexed world. In this noble task, the genius of the Commonwealth is behind the Sovereign.

His Majesty as the inheritor of the rich traditions of the Throne and of the achievements of the British race is a representative of the national history. He is the cornerstone of the Empire. The affection and esteem in which his subjects hold His Majesty and the singular popularity which

he enjoys throughout the world by the sympathy and tenderness with which he approaches international problems are an invaluable asset for the Empire. The world can pay no nobler tribute to its greatest monarch on this auspicious occasion than re-explore the possibilities of achieving international peace, prosperity and contentment. All the nations of the world have, in a smaller or greater measure, contributed to disorganise the international economic structure and to arouse mutual suspicions, jealousies and passions; and in rehabilitating international life on the basis of goodwill, truthfulness, honesty and amity, the contribution must be made in a spirit of Christian humility. The different races have to make large sacrifices in the interests of humanity and live as a brotherhood of nations and not divided into warring camps.

It is in this spirit of broad kindness and sympathy that His Majesty's reply to the Dominions representatives is conceived and it is worth reproducing in full:

"There is a word which gladdens me, more especially when I hear it used by friends from the overseas, many of whom say, when they visit this country 'they are coming home'. It is in this spirit that the Queen and I meet you to day, you who represent the vast territories, the Dominions, the Colonies, the protectorates and my peoples in India and the dwellers in the countless Isles of the sea from the Pacific to the homewaters. We greet the Prime Ministers of the Dominions, now equal partners in the Empire, and thank them for the addresses from their Parliaments which they have handed to me. We welcome one and all to our home.

"Eventful your visit cannot fail to be and I trust it will be happy also. When the time comes for you to return, I would ask you to take back, each to his own people, a message of affection

to every member of this great family, of which I am so proud and thankful to be the head; and a message of deep gratitude for the loyal and kind words which you have spoken on their behalf. You all, who are here to-day and who hold responsible positions, will best know what an inspiration and encouragement your words are to me to continue the task which, 25 years ago, I set myself to do. Before I succeeded my father, the Queen and I had the privilege of studying firsthand the Dominions Overseas and India. We were fellow-travellers then, as now, comparing notes and sharing impressions. We treasure these memories and keep them alive. Moreover, what we forget, our four sons are now able to recall. Many years before our happy partnership began, I had, as Midshipman, sailed the seven seas and I realised early that the Empire has many climes but one spirit.

"I regard this as a unique gathering where we can tell one another our successes as also our failures and mistakes, but there can be no sharp criticism nor vain regrets, for we are, in sympathy, one with another, conscious that we have acted according to our lights for the good name and ordered prosperity of the family. We are some time told that we are lacking logic, and that our political institutions are loose and undefined; but I look back on the trying and testing time through which we have passed and wonder whether a less flexible system would have withstood the strains to which we have been subjected. With common-sense and goodwill as our shield buckler, we have kept in spite of all difficulties our heritage—liberty alike for the individual and our many constituent races. The numberless and invisible ties, sentiment and tradition, which bind us together, are indeed delicate, but many strands make the cable strong to bind in times of adversity. It is my prayer, no less than my firm belief, that this bond of spirit may prove also the bond of a peace. Some of you are, with a few happy exceptions, about my own age and I pray for the continuance of God's blessings on your labours. With His help, I will work on with you in the years that remain for that object which has ever been next to my heart—welfare of the mother country, the Dominions Overseas and India, their happiness and their good repute."

Coloured Races in South Africa.

THE news of the appointment of a Commission of Enquiry by the Ministry of the Interior, Fusion Government of South Africa, for the investigation of social, educational and economic needs of the Cape "coloured" community, will be welcomed by all those interested in the question of race and colour. The "coloured" races are the admixture of the white European and the native Hottentot, Negro, and Malays. The "coloured" man is a slum dweller in the town. The death rate is 2.4 times as high among the "coloured" race, as among the white; the death rate

due to tuberculosis among the European is 0.68 per 1,000 while it is 4.69 per 1,000 among the non-European. Bad housing, insufficient food and miserable industrial conditions, are responsible for the heavy death toll and a searching enquiry into the causes of the unhappy state of affairs is imminent. The appointment of the Committee indicates that thoughtful South Africans are becoming increasingly uneasy with the conditions of the unfortunate "coloured" races and that they are out to eradicate the distress among them.

Light Scattering and Raman Effect.

By S. Bhagavantam.

INTRODUCTION.

THE discovery of the Raman Effect in 1928, has created a new chapter in the branches of spectroscopy and molecular physics with the result that the phenomenon of light scattering, which interested only a few men of science in the past, has become the subject of intensive investigation in recent years in various centres of research. The extreme rapidity with which the concerned literature has grown renders it very difficult to present a concise and complete picture of the advance that has been made in different branches of physics and chemistry. In a few publications, well known to the workers in the field of light scattering, Kohlrausch,¹ Weiler,² Placzek³ and others⁴ have successfully attempted to give authoritative and up-to-date summaries of the subject from time to time. The purpose of the present article is to give a very brief account of the discovery and the development of Raman effect and its relation to Rayleigh scattering with special emphasis on the more important fields of research that have recently been opened up.

RAYLEIGH SCATTERING.

The idea that the blue colour of the sky is the result of the scattering of sunlight by the molecules of the atmosphere was first put forward by the late Lord Rayleigh who also ventured the suggestion that the known imperfect polarisation of sky-light might in part be due to a lack of spherical symmetry of the molecules. All subsequent work supported this theory of the blue sky, and experimental investigations by Cabannes, the present Lord Rayleigh and others furnished confirmation of it by observations of such scattering made in the laboratory. The recognition, by Professor Raman, that the blue of the oceanic waters is another natural optical phenomenon which presents a close analogy to the blue of the sky was another important step in the history of the subject. These fundamental observations were soon followed by intensive and detailed

experimental investigations in India and other countries which were intended to discover the various laws governing the phenomenon of light scattering. The first important observations relate to the fact that the light scattered in a direction transverse to the incident beam invariably exhibits a state of partial polarisation, the degree of depolarisation or the ratio of the horizontal to the vertical components being characteristic of the substance under investigation and its state of aggregation. As the subject advanced, it has become clear that this phenomenon is of a very general nature involving the solution of fundamental questions regarding the interaction of matter and radiation and a systematic study of substances covering the widest range of physical states and conditions has been undertaken by Raman and his collaborators at Calcutta. Such investigations revealed that there are two types of scattering which may respectively be termed the density scattering and the orientation scattering. The density scattering arises from the existence of a molecular chaos in the medium giving rise to local fluctuations in density and its intensity is therefore profoundly influenced by temperature, state of aggregation, compressibility and such other factors which characterise the medium as a whole. This type of scattering is completely plane polarised in the transverse direction. The orientation scattering on the other hand owes its origin to an optical asymmetry of the molecules which constitute the medium and orientate freely in it and is thus determined *primarily* by a property of the individual molecules and not the medium itself. This type of scattering is nearly completely unpolarised.

The earlier investigations based on both visual and photographic methods, while thus leading to a clear recognition of the fact that the scattered beam in general consists of two parts which are fundamentally different, also led to the belief that these two types are superposed on each other resulting in an admixture of a completely polarised beam with a partially polarised beam. No indications were forthcoming which suggested that a change of wavelength is possible in the process of scattering

¹ K. W. F. Kohlrausch, "Der Smekal—Raman Effekt" (Julius Springer) and other articles.

² J. Weiler, *Physikal. Z.*, 1932, 33, 489.

³ G. Placzek, *Handbuch der Radiologie*, 1934, 2nd Edn., 6, 205, and earlier communications.

⁴ S. Bhagavantam, *Ind. Jour. Phys.*, 1930, 5, 237.

⁵ J. Hibben, *Chem. Rev.*, 1933, 13, 345.

and no attempts were made to experimentally separate the different types of scattering. Progress in the subject was hampered by the limitations inherent in the methods of observation and it was not until the discovery of the Raman effect that the full significance was realised of the above results and of the necessity of separating the different types of scattering.

RAMAN EFFECT AND ITS RELATION TO RAYLEIGH SCATTERING.

The earliest indications of the existence of a new type of scattering are available from the investigations of Ramanathan at Calcutta in 1923. By interposing a filter in the path of the incident beam which consisted of a concentrated track of sunlight, he limited the spectral range of illumination and found that most liquids exhibited a feeble trace of scattering in the transverse direction even when examined through another filter complementary to the one placed in the incident track. This observation gave an unmistakable indication of a new type of scattering which differed from the incident beam in having an altered wave-length and a persistence of this phenomenon even after the liquids had been carefully purified by repeated distillation showed that it did not arise from any impurities in the manner of fluorescence or otherwise. The necessity of spectroscopically separating from the general scattering the track observed through the complementary filter soon became clear. It was realised that the scattered beam visually seen was a composite effect in a much wider sense than was till then presumed, as it consisted of a whole spectrum of different wave-lengths even when the incident light was restricted to a narrow spectral range. A mercury arc was substituted in the place of filters and sunlight and a spectrograph in the place of the eye. Systematic investigations carried out by Raman with a variety of substances revealed the presence of a number of sharp lines or bands which were not present in the light of the mercury arc.⁶ This forms the starting point of the study of the Raman effect and the experiments were immediately extended to a large number of liquids, solids, gases and vapours and in a few months after the discovery it was found that one of the most powerful and yet easily accessible fields of research in

the study of the structure of molecules had been opened up. The technique was greatly improved and the general features characterising the Raman spectra were rapidly discovered in the following years.

Besides the lines originally present in the incident radiation the scattered spectrum usually consists of new lines or in some cases bands and unresolved continuous radiation shifted from a parent line by different extents. Each line in the incident spectrum, if of sufficient intensity, gives rise to its own set of lines and bands and the frequency shifts are independent of the nature and position of the incident radiation and are therefore only characteristic of the particular material studied. The individual Raman lines show generally great differences in their intensity and width and their number and variety are found to increase with increasing complexity of the molecule. Just as the Rayleigh scattering exhibits depolarisation, the Raman lines and bands exhibit a variety of polarisation characters. Some of them are strongly polarised and others highly depolarised. Attempts to interpret these apparently different types of Raman scattering (sharp lines, broad lines, diffuse bands, continuous spectrum, unresolved wings associated with the original lines, etc.) and their widely different intensity, structural and polarisation characters revealed an intimate connection of these features with the structure of the scattering molecules and the mechanism of the phenomenon of scattering. Subsequent experimental and theoretical investigations have resulted in a considerable advance of our knowledge regarding these questions.

GENERAL THEORY OF THE RAMAN EFFECT.

The simplest picture that may be obtained of the production of a Raman line has been proposed by Raman himself³ and consists in regarding the collision between the molecule and a light quantum as satisfying the law of conservation of energy. The equation

$$h\nu + \text{Molecule (normal)} \rightleftharpoons h\nu^* + \text{Molecule (excited)}$$

represents the passage of a molecule from a normal state to an excited state the energy of the light quantum diminishing from $h\nu$ to $h\nu^*$ if the transformation proceeds from left to right and *vice versa* if it proceeds in the opposite direction. As a result of the collision, the molecule is left in a state of altered energy and the light quantum as it is scattered, supplies or takes up the difference

⁶ C. V. Raman, *Ind. Jour. Phys.*, 1928, 2, 387.

of energy as the case may be. This manifests itself as a Raman line shifted from the position of the parent line by a distance equivalent to the energy change. Theoretically it is possible to conceive of the molecules changing either their electronic, vibrational or rotational energy alone or any combinations of these with the result that one should expect different and complicated types of Raman scattering which are respectively analogous to the cases of electronic (visible and ultraviolet), vibrational (near infra-red) and rotational (far infra-red) spectra of molecules. This implies the appearance of very complicated Raman spectra which may be directly correlated with the absorption spectrum of the substance in the visible region if we are dealing with electronic transitions and in the infra-red region if we are dealing with vibrational or rotational transitions. In practice, however, it is the latter type that are frequently met with in Raman spectra* and we need consider only these in the following pages.

After a few preliminary investigations, it soon became clear that there is no exact one to one correspondence between Raman lines and the infra-red absorption spectra and it was concluded that the simple equation, while indicating that an energy change similar to the one occurring in direct absorption is also responsible for the production of a Raman line, is not adequate enough to give a complete picture of the phenomenon. The primary defect of this equation is that it does not tell us anything about the relative probability of each one of the several transitions that are possible between the various stationary states of a molecule if it possesses more than two such states. In other words we cannot anticipate the relative intensities of various Raman lines.

A satisfactory explanation of these and other facts on the basis of the Kramers-Heisenberg dispersion theory has been worked out by Langer⁸, Hill and Kemble⁹, Van Vleck¹⁰, Manneback¹¹, Placzek³ and others

* The electronic type of Raman Effect has been detected only in one favourable case (See Reference 7). The reason for such an infrequent occurrence of this type is presumably the large change of energy that is usually involved.

⁷ F. Rasetti, *Phys. Rev.*, 1929, **34**, 548.

⁸ R. M. Langer, *Phys. Rev.*, 1929, **33**, 1097.

⁹ E. L. Hill and E. C. Kemble, *Proc. Nat. Acad. Sci.*, 1929, **15**, 387.

¹⁰ J. H. Van Vleck, *Proc. Nat. Acad. Sci.*, 1929, **15**, 754.

¹¹ C. Manneback, *Z. f. Phys.*, 1930, **62**, 224.

¹² C. Manneback, *Nature*, 1930, **125**, 88.

and it was evident from the investigations of these authors that the selection rules controlling the appearance of a Raman line are very different from those that favour the production of infra-red absorption and as such a certain lack of correspondence between them should be expected. The general results of the Kramers-Heisenberg dispersion theory and its detailed application to diatomic gaseous molecules are contained in a very important paper by Manneback¹¹ who, besides furnishing for the first time quantitative expressions in certain simple cases for the intensity and polarisation characters of Raman lines, brought out a very fundamental relationship between the optical properties of the molecule and the phenomenon of Raman scattering. He showed that just as the intensity and depolarisation of the Rayleigh scattering are intimately connected with the refractivity and anisotropy of the scattering molecules, so also the intensity and depolarisation of the Raman scattering are consequences of the existence of a finite variation of these quantities (refractivity and anisotropy of the molecules) with varying nuclear distances.

Exactly similar conclusions have been reached from different points of view by other investigators^{13, 14} and the fundamental ideas underlying the theory have been successfully extended to polyatomic molecules by Placzek³ who worked out in great detail the intensity and polarisation characters that are to be expected for various lines due to molecules possessing different types of symmetry.

VIBRATIONAL RAMAN LINES: PROBLEMS RELATING TO THE STRUCTURE OF MOLECULES.

As has already been remarked, the number and variety of Raman lines given by a substance increases rapidly with the complexity of the molecule and it becomes increasingly difficult to interpret the results in a complete and satisfactory manner. Nevertheless, conclusions of outstanding significance have been drawn by Ganesan and Venkateswaran¹⁵, Daure¹⁶, Dadiou and

¹³ S. Bhagavantam, *Ind. Jour. Phys.*, 1931, **6**, 351.

¹⁴ J. Cabannes and Y. Rocard, *J. Phys. et le Rad.*, 1929, **10**, 52.

¹⁵ A. S. Ganesan and S. Venkateswaran, *Ind. Jour. Phys.*, 1929, **4**, 195, and subsequent papers.

¹⁶ P. Daure, see numerous papers by him in *Comptes Rendus* and *Annales de Physique*.

Kohlrausch¹⁷, Bonino and Brull¹⁸ and others from a study of the Raman spectra of complicated organic and inorganic molecules. The identification of certain frequencies as characteristic of definite groups or linkages has been of immense help in determining the constitutions of molecules. The problems of distinguishing different isomers with the help of Raman spectra, of following physico-chemical transformations such as association, dissociation, polymerisation, hydrate formation, esterification and numerous other changes which involve an alteration in the structure of the scattering unit have usefully engaged the attention of workers in this field.

Even more fruitful are the investigations relating to simpler substances and in certain cases detailed studies have shown how remarkably the ultimate structure of the molecule comes into evidence in the Raman effect. The most striking case has been that of hydrogen and the pioneer work of McLennan and his collaborators¹⁹ with this substance has furnished the first experimental proof of the existence of two forms of hydrogen and of the process of slow transformation of one form into the other at liquid hydrogen temperatures.

Subsequent investigations by Rasetti and others²⁰ with many simple gases have led to a direct and accurate measurement of their vibration frequencies. Special mention may be made here of the cases of CO_2 , CS_2 , N_2O and SO_2 . These triatomic molecules, in view of their simplicity, have been the subject of intensive investigations and evidence is to-day available which definitely decides the structure of each one of these molecules. Only a brief mention will be made here of the main results. The spectra of CO_2 and CS_2 are very similar in that two prominent and closely situated Raman lines are observed, each of which has in addition a faint component. The strongest line in each case corresponds to a symmetric expansion of the molecule and is not represented

in infra-red absorption. The two principal infra-red absorption bands on the other hand at 675 and 2350 cm^{-1} in CO_2 and 397 and 1523 cm^{-1} in CS_2 are not represented in the Raman effect.* All these facts point to a linear symmetrical structure of these two molecules. The case of N_2O is on a different footing as the strongest line in the Raman-spectrum is represented by a weak band in the infra-red absorption and one of the principal absorption bands at 2226 cm^{-1} is also represented in the Raman-spectrum quite unlike CS_2 and CO_2 . This indicates an unsymmetrical linear structure for N_2O .† Contrary to all these cases, the triangular shape and the consequent polarity of the SO_2 molecule come into evidence in its Raman-spectrum in a striking manner as it consists of one sharp line and two diffuse bands all of which are represented in the infra-red absorption.

Investigations with slightly more complicated molecules of the type AX_3 , AX_4 and AX_6 besides furnishing for the first time a direct measure of the fundamental vibration frequencies in certain cases have revealed interesting relationships between the nature of the constituent atoms and the binding forces. Extensive theoretical calculations^{21 22 23 24 25 26 et al} made with a view to quantitatively account for the number and actual values of the observed frequency shifts in the Raman spectra of these molecules have revealed the necessity of taking into account a variety of interatomic forces and the results obtained are of special interest from the point of view of the building up of molecules.

INTENSITY AND POLARISATION CHARACTERS OF RAMAN LINES.

All the above conclusions regarding the structure of molecules have received

* There is a very weak band at 400 in the Raman spectrum of liquid carbon disulphide. This should be regarded as an exception.

† That the structures of CO_2 and N_2O differ in that one is symmetrical while the other is unsymmetrical is also evident from the fact that the phenomenon of alternating intensities is seen in the rotation spectrum of CO and not N_2O .

²¹ Urey and Bradley, *Phys. Rev.*, 1931, 38, 1969.

²² Vedder and R. Mecke, *Z. f. Phys.*, 1933, 86, 137.

²³ O. Redlich, F. Kurz and P. Rosenfeld, *Z. f. Physikal. Chem.*, 1932, 19, 231.

²⁴ D. M. Yost, C. C. Steffens and S. T. Gross, *Jour. Chem. Phys.*, 1934, 2, 311.

²⁵ N. S. Nagendranath, *Ind. Jour. Phys.*, 1934, 8, 581; and *Proc. Ind. Acad. Sci.*, 1934, 1, 250.

²⁶ G. B. B. M. Sutherland and L. M. Dennison, *Proc. Roy. Soc.*, 1935, 148, 250.

¹⁷ A. Dadieu and K. W. F. Kohlrausch, A series of about 40 papers have been published by these authors and their collaborators mainly in *Sitz. Akad. Wiss., Wien*.

¹⁸ G. B. Bonino and L. Brull, See numerous papers by these authors in *Gazzetta Chimica Ital.*, and *Rendiconto Acad. Lincei*.

¹⁹ J. C. McLennan, *Trans. Farad. Soc.*, 1929, 25, 797.

²⁰ R. G. Dickinson, R. T. Dillon and F. Rasetti, *Phys. Rev.*, 1929, 34, 582, and other papers by Rasetti himself.

independent confirmation from a study of the intensity and polarisation characters of the various lines in Raman spectra. In spite of the more numerous experimental difficulties in the way of an accurate study of these features, results of fundamental and far-reaching importance have been obtained. Definite progressions in the intensity and polarisation characters of the corresponding lines in the Raman spectra of analogous molecules such as the trichlorides or the tetrachlorides have been discovered and a correlation is found to exist between the characters of a line and the type of symmetry of the oscillation giving rise to it.²⁷ An application of the polarisability theory by Placzek to special and simple cases like CO₂ and CS₂, whose vibrational spectra have been the subject of important theoretical investigations by Fermi, Dennison and Placzek, has raised several fundamental issues. This resulted in a detailed experimental study by recent investigators of the intensity and polarisation phenomena in the Raman spectra of these molecules^{27 28 29 30} and a more or less complete and satisfactory explanation is now available of the origin of the numerous lines exhibited by them. It has already been remarked that the presence of a weak, broad and depolarised Raman line at 400 cm.⁻¹ in liquid carbon disulphide should be regarded as an exception.³¹ A feature of these molecules, which is of further interest, is the existence in them of a special type of resonance giving rise to Raman lines which are to be regarded as overtones. The relatively low energy of the first vibrational state is also responsible for the presence of Raman lines which represent transitions from the first excited state to a higher vibrational energy level. These characters are somewhat exceptional as they are not frequently met with in Raman spectra.

Investigations of this type have also been extended to more complicated molecules and results of great theoretical importance obtained in connection with the ratio of intensities between Stokes and anti-Stokes Raman lines, dependence of the intensity and polarisation of a Raman line on the frequency

of the exciting radiation, variation of intensity and polarisation within the structure of the line itself and other allied problems.

RAYLEIGH LINE: ITS FINE STRUCTURE AND ACCOMPANYING WINGS.

It has already been mentioned that the Raman spectra fall into two major classes which arise respectively from the vibrations and rotations of the molecules. Till now we have dealt with only the former type of Raman scattering. The latter type manifests itself as closely spaced lines or unresolved wings in the neighbourhood of the Rayleigh line. It is for this reason that the Rayleigh lines obtained in the Raman spectrum of a substance are not usually sharp even when the incident light is strictly monochromatic. Such a broadening or diffuseness has been first recognised in liquids by Raman and Krishnan³² who associated it with rotation of molecules. Subsequent investigations relating to this aspect of the subject were however confined to gases and have revealed the presence of similar wings in their scattered spectra but contrary to the case of liquids these could be resolved into separate and closely spaced lines under suitable conditions and definitely attributed to the rotation of molecules as their positions could be correlated with the moments of inertia of the scattering units. The very admirable work of Rasetti, Wood and others on the Raman spectra of simple gaseous molecules has furnished convincing proof of the above statements. Amongst the many notable results obtained by these investigators mention may be made of the phenomenon of alternating intensities amongst the rotation lines of hydrogen and nitrogen gases. This discovery has led to an accurate and direct determination of the relative populations of the two different kinds of hydrogen molecules and to a recognition of the important fact that the nitrogen nucleus, while possessing a spin moment of one Bohr unit, conforms to the Bose-Einstein statistics and not to the Fermi-Dirac statistics.

In liquids, on the other hand, detailed investigations on the subject were lacking for a long time and the diffuse wings noticed on either side of the Rayleigh lines were attributed to the rotation of liquid molecules only by analogy with the case of gases. Systematic experimental studies carried out

²⁷ A. Langseth, J. U. Sorensen and J. R. Nielsen, *Jour. Chem. Phys.*, 1934, 2, 402.

²⁸ A. Langseth and J. R. Nielsen, *Phys. Rev.*, 1934, 46, 1057.

²⁹ I. Hansen, *Phys. Rev.*, 1934, 46, 122.

³⁰ A. Veerabhadra Rao, under publication.

³¹ S. Bhagavantam, *Ind. Jour. Phys.*, 1932, 7, 79.

³² C. V. Raman and K. S. Krishnan, *Nature*, 1928, 122, 278.

by a number of investigators^{33 34 35 36 37 38} have recently brought to light some significant and fundamental differences between the wings that are met with in liquids and those obtained in gases. In most liquids, the distribution is such that the wing starts with a maximum intensity at the centre itself and extends to much longer distances than is expected on the basis of Maxwellian distribution of rotational energies. That such a phenomenon cannot be explained as due wholly to the rotation of molecules and that the patterns in liquids should be regarded as superpositions of a rotational Raman effect on another and more complex spectrum characteristic of the solid state has first been pointed out by the present writer.³⁶ Striking results in this direction have recently been obtained by Gross and Vuks³⁹ who showed that the wings observed in liquid benzene, naphthalene and diphenyl ether are replaced by broad bands when the Raman spectrum of these substances is studied in the solid state. It is suggested that these bands broaden out into a continuous spectrum in the liquid state and the observed wings result from a superposition on this of the pure rotation pattern. This result implies that some characteristics of the solid are preserved beyond the melting point of the substance and is of great significance as it opens up a new line of investigation which promises to throw light on the important question of the nature of the liquid state.

Intimately connected with this aspect of the subject is the phenomenon of fine structure of the Rayleigh scattering in liquids discovered by Gross⁴⁰ who examined the scattered lines under high dispersion and found a whole series of satellites on either side of a central line which is itself in the position of the incident radiation. Several investigators^{41 42 43 44 45} have subsequently

examined this question but the results reported in most cases were unsatisfactory and indecisive. Recent systematic investigation of this phenomenon, undertaken by Raghavendra Rao at Bangalore, has yielded very significant results. Besides the undisplaced line, only two components have been located one on either side of it. The positions of the displaced components and the effect on the same of changing the frequency of the incident radiation are in satisfactory agreement with the predictions of the Einstein-Brillouin theory of light scattering in solids. The presence of central undisplaced component is not however contemplated in this theory and should not appear if we are dealing with solids. Its presence is characteristic of the light scattered by a gas and the results therefore indicate that the liquid state resembles a solid in certain respects and a gas in certain other respects. The general picture obtained of the liquid state from a study of the fine structure of Rayleigh lines is thus more or less the same as that deduced from independent investigations relating to the phenomenon of wings. It is obvious that both these lines of work are of fundamental significance and much remains to be done in this direction.

CONCLUSION.

In conclusion it must be pointed out that in the foregoing paragraphs, no attempt has been made to present a complete picture of the state of the subject but only a brief mention has been possible of the many outstanding results that have so far been obtained. Although the direct and simple problems that arise from a study of light scattering have already been successfully tackled, there remain yet to be investigated the more recondite phenomena such as the effect of increasing pressure and density on the Raman spectra of gases, the relation of such effects to the phenomena exhibited by dense media such as solids and liquids, the nature of the solid and liquid states, the relation of the amorphous state to these and numerous other problems of this type. Recent investigations have shown that a study of the Raman effect under high dispersion, light gathering power and other suitable conditions constitutes one of the most powerful lines of attack in the solution of the above problems and the future development of the subject will undoubtedly proceed on these lines.

⁴⁵ B. V. Raghavendra Rao, *Proc. Ind. Acad. Sci.*, 1934 and 1935, 1, 261 and 473.

Hydraulic Seismographs.

By S. K. Banerji.

FOR the last three years we have been experimenting on a type of seismographs which have several interesting features. These instruments are based on a method of hydraulic magnification and damping first enunciated by Prof. Kapitza in connection with his experiments on magnetization in very strong magnetic fields. The earlier forms of seismographs constructed on this principle were described in a note in *Nature*, page 547, Vol. 131, 1933; they were not found very satisfactory for the recording of distant earthquakes as owing to their low free periods (about 2 or 3 seconds) and large constraints, they were not sufficiently responsive to slowly varying impulses. They were, however, found to be highly sensitive to quick period movements of the ground, such as would be produced by dropping a weight, or a buried "explosion", and being portable were considered to be a very suitable type of instruments for geo-physical prospecting.

Since writing the above note in *Nature*, the instrument has been considerably improved. The earlier form of the apparatus for the recording of the vertical component of the ground movements consisted of a cylindrical cup whose lower face was closed by a metal diaphragm, and a narrow tube was attached horizontally fitting a small hole in its side, in which a small mirror was suspended from an axle (Fig. 1). A cylindrical jacket covered the cup all round except the diaphragm at the bottom. Some highly viscous oil, such as paraffin or castor oil, was poured into the inner chamber and the diaphragm was then loaded by attaching a weight of about a kilogram or more to a rod passing through its centre. The vertical component of the ground movements sets up oscillations in the membrane and forces the oil to move to and fro through the narrow tube and thus gives a large oscillatory angular motion to the mirror which is recorded photographically.

The apparatus is shown diagrammatically in Fig. 1.

ABCD is the inner chamber, of which the lower face, CD, consists of a thin metal diaphragm of 36 S.G. EFGH represents the outer vessel. T is a narrow tube in which a small mirror M is suspended from a horizontal axis. G is a glass window in the outer vessel to admit light for illumination.

A beam of light from a collimator telescope is made to fall on the mirror M and is reflected on a photographic paper wrapped

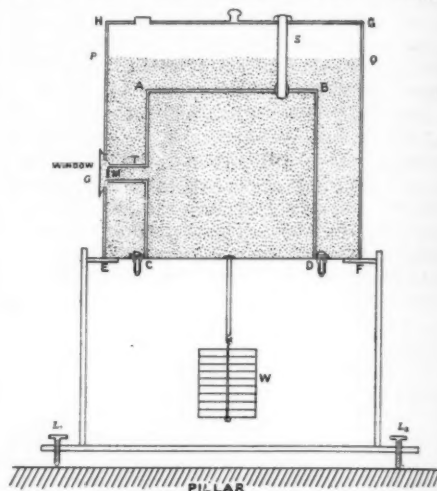


Fig. 1.

round a recording cylinder. W is the weight attached to the diaphragm. S is a tube through which some viscous oil, such as paraffin or castor oil, is poured and the chamber filled up to a height PQ so that the inner vessel is completely full of oil.

When the diaphragm CD moves upwards, the oil is forced out through the narrow tube T, the motion in the tube being magnified in the ratio of the area of the diaphragm to that of the section of the tube. The mirror therefore acquires a large angular motion about a horizontal axis. The whole instrument rests on a cast iron platform with three levelling screws L_1 , L_2 , L_3 .

In one instrument used in these experiments, the following were the constants:—

Diameter of inner vessel	= 15 cm.
Height of inner vessel	= 15 cm.
Diameter of diaphragm (tin)	= 15 cm.
Thickness of diaphragm (tin)	= 0.019 cm.
Diameter of outer vessel	= 23 cm.
Height of outer vessel	= 23 cm.
Diameter of tube	= 1.9 cm.
Weight suspended	= 1 kg.
Mechanical magnification	= 60 times.
Optical magnification	= 10 times.

Total magnification	=600 times.
Period	= 2.3 secs.
Damping ratio	= 5 : 1.

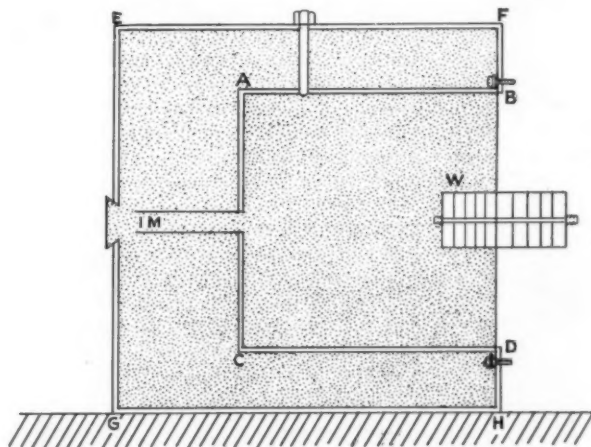
The oil used was castor oil.

Using a brass diaphragm of thickness 0.02 cm., a period of 2.5 secs. and a damping ratio of 5 : 1 was obtained.

If the vessels are of brass, castor oil (even when pure) produces chemical action and it slowly becomes green. To avoid this, the vessels were all nickel-plated.

For illumination, a collimator telescope with a 6-volt straight filament lamp was used. The recording apparatus consisted of a vertical cylinder, of length 6 inches and diameter 6 inches, rotating and at the same time moving vertically downwards along a spiral. The cylinder makes a revolution once every hour and undergoes a downward displacement of about a centimetre during

obtained by cutting off the light for 2 or 3 secs. every minute by means of the usual electromagnetic shutter. An instrument of this kind was kept in action for several months. During the period, the instrument gave good records of microseisms but the records of distant earthquakes were not satisfactory. Experiments were therefore made with membranes of other kinds. A leather membrane of diameter 6 inches and thickness 0.06 cm. such as is used in musical drums would increase the period to about 3.2 seconds, and the damping ratio to 7 : 1. The instrument becomes more sensitive to earthquake waves but the "zero" remains unstable until the membrane settles down to some steady conditions. Usually, however, when the instrument is used in this form leaks occur in the membrane after a few weeks' use. The same remarks apply also to rubber



PILLAR

Fig. 2.

the interval. The speck of light on the photographic paper wrapped round the cylinder traces a spiral. The motion of the recording cylinder down the spiral is controlled by a clock. The motion really occurs under gravity but the clock acts as a brake. As the cylinder rotates in the same direction as the minute hand of the clock, the falling cylinder keeps the clock going. No power is required from the clock, and an ordinary cheap spring-driven clock may be used for the purpose. Time mark is

membranes. A rubber membrane of diameter 15 cm. and thickness 0.08 cm. gives a period of 3.4 seconds and a damping ratio of 7 : 1. If a membrane of larger diameter is used, the period is increased, but it does not always oscillate in the gravest mode.

A similar arrangement was adopted for the recording of horizontal component of the ground movement (Fig. 2). The membrane, BD, is in the vertical plane and is loaded at its centre by two symmetrical weights fixed on either side of a horizontal rod,

The frequency N of a loaded diaphragm with water on one side and a mass m at the centre is given by

$$N = 0.4745 \frac{hc}{a^2} \sqrt{\frac{1}{1 + \beta + 5m/M}},$$

where h is the thickness of the diaphragm, c the velocity of elastic waves in an infinite thin plane of the same material, $\beta = 0.668 \rho'/\rho h$, ρ' being the density of liquid, ρ density of material of the membrane, m mass suspended from centre of diaphragm and M the mass of the diaphragm. For a rubber membrane, taking $E = 10 \times 10^{11}$ dynes/cm.², $a = 7.5$ cm., $h = 0.021$ cm., $\sigma = 0.35$, $\rho = 0.9$, $\rho' = 1$, $c^2 = E/\rho(1 - \sigma^2)$, we get the period equal to about 1.5 seconds. The observed period is 3.4 secs. for a rubber membrane of this type. The smaller value given by the above formula is due to its not taking full account of all the physical effects. If we take account of the fluid and its movement into account, then, a more accurate formula for the frequency is

$$N^2 = \frac{1}{4\pi^3 B A^2 \gamma p} \cdot \frac{h^3 d^2}{a^6},$$

where γ = sp. gr. of oil, p = effective length of channel, h = thickness of membrane, d =

centre of the membrane and this 'mass' is comparable to the weight of the liquid which rests on the membrane. It does not therefore act as a free mass. A "mass" which would remain stationary when an impulse is communicated to the instrument would require to be considerably greater than the weight of the oil. Without a suitable stationary mass, the differential motion (i.e., motion with respect to the stationary mass) communicated to the membrane by ground movement is very small.

In the later models, therefore, the design of the vertical component seismograph was modified to that shown in Fig. 3. In this form the whole instrument, which is suspended from a rigid support by means of a rod attached to the centre of the membrane, AC, acts as a stationary mass. If the support moves vertically downwards or upwards through a distance δx , the centre of the membrane moves through a distance δx and thus forces out or draws in the oil through the tube. In practice this form of the instrument was also found not to work very satisfactorily. This was due to the membrane being strained and assuming a conical

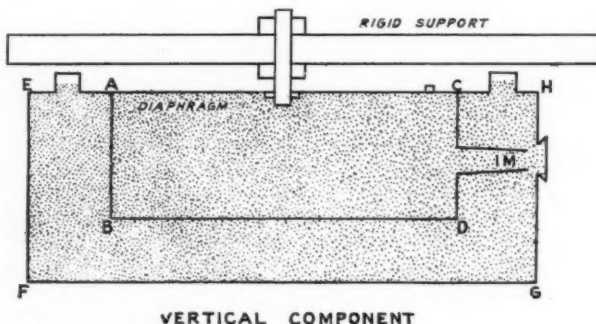


Fig. 3.

diameter of opening of mirror tube, a = diameter of the membrane and A and B are two constants. For a seismograph fitted with a brass diaphragm, the data were $h = 0.021$ cm., $d = 1.9$ cm., $\gamma = 0.95$, $A = 0.36$, $B = 8.77 \times 10^{-14}$, $p = 2 \times 1.75 \times 2.54$ cm. The period comes out to be 2.02 secs. This is very nearly the observed period.

The above form of the vertical or horizontal component seismograph is clearly defective. For, there is a limit to the mass which can be suspended from or fixed to the

shape under the weight which it had to support.

To remedy the above defect the instruments were modified to the forms shown in Figs. 4 and 5. The horizontal component is suspended by a bi-filar string from the roof of the building so that the plane of oscillation is in the direction in which the horizontal component is to be recorded. It is found that the best sensitiveness is obtained when the length of the string is such as to give a period equal to the free period

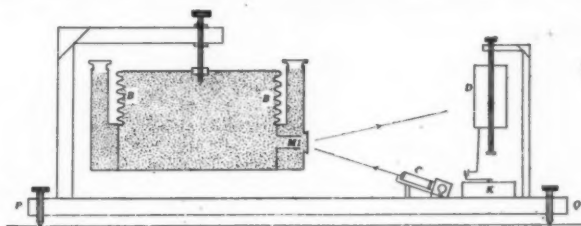


Fig. 4.

Vertical Component.

BB—Flexible Bellows. M—Mirror. C—Collimator Telescope. D—Recording Cylinder.
K—Driving Clock. PQ—Cast Iron Stand.

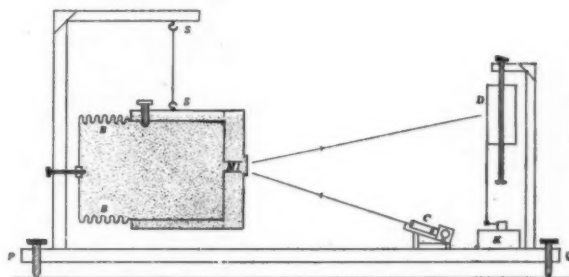


Fig. 5.

Horizontal Component.

BB—Flexible Bellows. M—Mirror. C—Collimator Telescope. SS—Suspension Wire.
D—Recording Cylinder. K—Driving Clock. PQ—Cast Iron Stand.

of the membrane. In these instruments the membranes used have cylindrical forms and consequently they undergo no abnormal deformation and retain their elastic after-working. The most suitable form of membrane for instruments of this type appears to be the flexible bellows (cylindrical), now manufactured on a commercial scale. The preliminary observations made with these modified instruments indicate that they are more sensitive to earthquake movements than the earlier forms.

Fig. 6 is the record of an earthquake and Fig. 7 of microseisms obtained with vertical component hydraulic seismograph.

The chief advantage of an instrument of this type lies in the fact that the parts are all assembled and it can be carried from one place to another and installed in working condition in a short time. Even the most violent movements of the ground cannot displace any of the working parts. The damping ratio can be increased to any de-

sired extent by making the tube in which the mirror is suspended tapering. The calibration of the displacement of the speck of light on the photographic paper in terms of the actual ground movements is readily made by arranging to give specified motions to the platform on which the instrument rests.

The chief defect of the instrument lies in its susceptibility to pressure fluctuation produced by gusts of wind. This effect arises on account of its functioning more or less like an aneroid box. It has been considerably reduced in the latest form of the instrument by making the box (including the oil) as heavy as possible consistent with the elasticity of the membrane, so that the variation in pressure fluctuation becomes negligible compared with the total weight which the membrane has to support. Nevertheless the effect is there and becomes conspicuous when a large magnification is adopted. The effect can be further reduced by installing the instrument in a

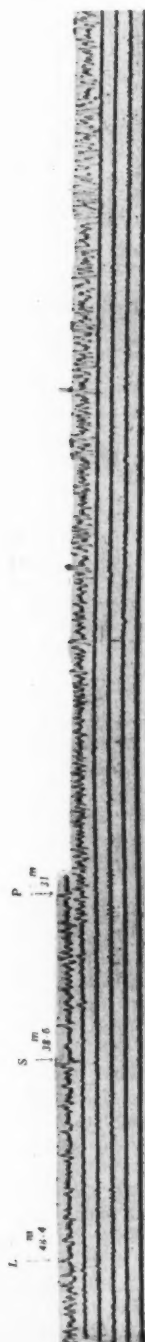


Fig. 6.

Record of an Earthquake by Hydraulic Seismograph (Vertical Component). Distance of Earthquake, 3,500 miles.
The interval between consecutive breaks equals one minute of time.

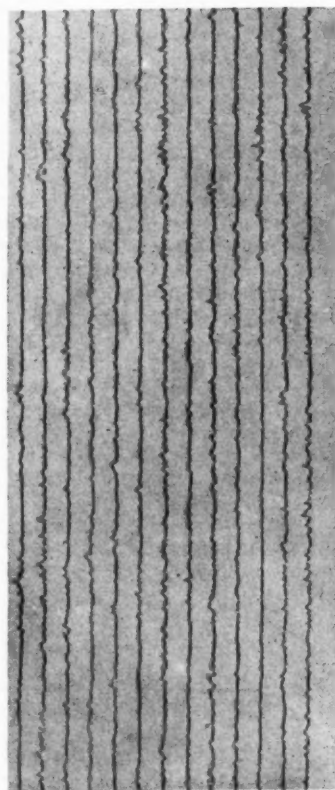


Fig. 7.

Record of microseisms by Hydraulic Seismograph, Vertical Component. (The interval between consecutive breaks equals one minute of time.)

double-walled room with an air-gap in between which acts as a damper to pressure fluctuations.

The instruments are still in an experimental stage and it is hoped to introduce further improvements in them.

My thanks are due to Mr. K. N. Sohoni who assisted me in taking the earlier series of observations.

Winters in the Punjab.

By J. B. Seth, M.A. (Cantab.), I.E.S.,
Professor of Physics, Government College, Lahore.

I WAS much interested to read the two articles in *Current Science* of February, 1935, on the recent cold waves by Drs. Ramdas and Roy of the Indian Meteorological Department. The cold wave of January, 1935, was undoubtedly much longer and, judged by the minimum shade temperatures (of air), much severer than that of 1929. Thus according to the tables given in Dr. Roy's paper, the 1929 cold wave lasted only 5 days while this year's lasted 9 days. Moreover, the air temperatures registered this year were decidedly lower than those in 1929.

I am writing this to bring it to the notice of those interested that the length and severity of a cold wave as judged by air temperatures do not seem to have much correlation with ground frosts, at least so far as the Punjab is concerned, if one may generalise from the weather data about Lahore which alone are available to me. Dr. Roy implies in his paper, and one would certainly be inclined to think, that since the minimum air temperatures registered in 1935 were much lower and for a much longer period than those registered in 1929, the ground temperatures in the current year would also have been lower than those in 1929. The state of affairs, however, at least so far as Lahore is concerned, is, strangely enough, just the opposite.

During the cold wave of this year the lowest temperature on grass registered in the local meteorological observatory was $19^{\circ}\cdot 0$ F. on the 18th January on which day the minimum shade temperature of air was also the lowest recorded during the cold wave, namely, $27^{\circ}\cdot 8$ F., which is, incidentally, the lowest air temperature ever recorded in Lahore since January 1879—data for years previous to this are not available in the local meteorological observatory. The lowest temperature on grass registered in 1929 was more than 4 degrees lower than that registered this year, namely, $14^{\circ}\cdot 7$ on the 31st January, 1929, on which date was also reached the lowest of air temperatures for that year's cold wave at $29^{\circ}\cdot 0$ F.

During the cold wave of this year the minimum air temperature in Lahore continued to remain below or at the freezing point for 7 mornings (13th to 19th January);

during 1929 the corresponding number was only three (31st January—2nd February). But this year ground frosts took place, besides, of course, the frosts of the seven mornings of the cold wave, only one day before and one day after the cold spell: on the 11th January the grass minimum was $37^{\circ}\cdot 0$, from the 12th to 20th it remained below the freezing point but then it shot up from $28^{\circ}\cdot 0$ on the 20th to $43^{\circ}\cdot 2$ on the 21st morning, due of course to the incidence of cloudy weather; and it never went below freezing after the 20th January though it once again touched $32^{\circ}\cdot 0$ on the 27th January. It may also be mentioned at this stage that before the incidence of the cold wave of this year there had been two to three degrees of ground frost for seven mornings from the 3rd to 9th January and that altogether during the 1934-35 winter there had been, before the incidence of the cold wave on the 12th January, 16 frosty mornings, the first frost of the season having been registered on the 26th November, 1934, when the minimum grass temperature went down to $28^{\circ}\cdot 9$ F. The minimum grass temperature of the 20th November had only just touched the freezing point, having been $31^{\circ}\cdot 9$ F. Thus the total number of mornings during the 1934-35 winter when the minimum grass temperature reached or went below 32° F. was 27 including the days of the cold wave.

The winter of 1928-29 in Lahore was much severer than this year's judging from ground frosts. Thus the frosts during the mornings of the cold wave of that year had been preceded as well as followed by three successive mornings. During the days when the cold wave was actually passing through Lahore, the grass minimum temperatures were $14^{\circ}\cdot 7$, $16^{\circ}\cdot 9$ and $15^{\circ}\cdot 2$ on the 31st January, 1st and 2nd February, 1929, respectively. These were followed altogether by 14 more frosty mornings upto the 19th February and had been preceded by a very large number of similar mornings. Thus between the 5th December, 1928, when the first frost of the season was registered, the grass minimum being $29^{\circ}\cdot 0$, to the 30th January, 1929, the eve of the incidence of the cold wave and on which morning $25^{\circ}\cdot 4$ was reached on grass, there had been 38 mornings on which the

minimum grass temperature went down to or below the freezing point. Altogether during 1928-29, the number of such mornings was 58, the first being the aforesaid 5-12-1928 and the last, 4-3-1929 with $29^{\circ}\cdot 1$ F.

It should be mentioned here that in 1929 the minimum grass temperatures were registered by a thermometer the bulb of which was kept in contact with a woollen pad laid on the ground. Since October 1933, however, the grass temperatures are being registered by a thermometer kept about an inch above the ground level on wooden cross supports. The so-called grass temperatures observed according to the latter, *i.e.*, the current practice will probably be a little higher than if the older method were used. But all the same, residents of Lahore will have no doubt about the frosts of January-February 1929 having been much severer than those of January, 1935.

It is interesting to note that January of this year (1935) had been preceded by an abnormally warm December. Between the 1st December, when the grass minimum had just gone below freezing (to $31\cdot 8$) to the 29th December, when it went again below freezing (to $30\cdot 2$), the mean temperature of the day (the mean of the maximum and minimum air temperatures in shade) remained above the normal mean temperature almost every day, so that the average of the daily mean temperatures for the month reached $57\cdot 6$, nearly two degrees above the normal monthly average (the mean of the 31 daily normal temperatures) of $55\cdot 7$. January was also followed by a warm February, the monthly average having been $59\cdot 4$ as against the normal average of $57\cdot 9$. However, compensation for these abnormally high averages was provided by the length of the cold wave and its having been followed as well as preceded by quite cold days. This made the monthly average temperature for January abnormally low, being only $51\cdot 2$ as against the normal average of $54\cdot 4$. With the result that the mean temperature for the 1934-35 winter season (1st November-15th March) comes out to be $59\cdot 2$, only a fifth of a degree above the normal mean for the same period.

I understand that officially the winter is regarded to last from the 15th October to 15th March. I have, however, regarded it to commence on the 1st November for the normal daily temperature of Lahore goes down below 70 (to $69\cdot 5$) on the 2nd November and remains below 70 till the 16th March

the normal temperature for which day is $69\cdot 6$. The normal temperature of 1st November is $71\cdot 1$ and of 17th March $70\cdot 6$. These normal temperatures for each day of the year were supplied to the local meteorological observatory certainly more than 20 years ago and perhaps should be revised. Returning, however, to the duration of winter in Lahore, I feel it should be regarded to last only for that period during which the normal daily average does not exceed 65°F . Applying this criterion the winter in Lahore should be taken to last from 15th November (normal temperature, $64\cdot 7$; the normal of 14th being $66\cdot 1$) to 6th March (normal temperature $64\cdot 6$; the normal of 7th being $65\cdot 7$). Table I summarises the points brought out in the foregoing.

TABLE I.

(giving a few details about the winters of 1928-29 and 1934-35 at Lahore. Temperatures are in degrees F.)

	1928-29	1934-35	Normal
Average temp. for Nov.	66.0	64.7	64.5
" " Dec.	56.9	57.6	55.7
" " Jan.	54.2	51.2	54.4
" " Feb.	58.0	59.4	57.9
" " March 1-15	69.0	67.6	66.1
Average temp. from 1st Nov. to 15th March. ..	59.6	59.2	59.0
Average temp. from 15th Nov. to 6th March. ..	57.6	57.1	57.2
No. of days when grass minimum reached or went below $32^{\circ}\cdot 0$..	58	27	..
No. of days when air minimum reached or went below $32^{\circ}\cdot 0$..	3	7	..
Lowest minimum air temperature recorded (with date) ..	29.0 (31/1)	27.8 (18/1)	..
Lowest minimum grass temperature recorded (with date) ..	14.7 (31/1)	19.0 (18/1)	..

I should also like to mention here that it does not seem to be very uncommon in Lahore and I suppose, therefore, in the plains of the Punjab generally, to find quite severe frosty mornings without the minimum air temperatures reaching even the freezing point. This as well as several other interesting features about Lahore winters are brought out in Table II which goes back to the winter of 1921-22.

TABLE II
(showing the relative severity of winters in Lahore.)

Season	Average temperature 1st Nov.—15th March, Normal for the period—59.0	No. of days when grass minimum reached or went below 30° F.	No. of days when 8 degrees or more of ground frost was registered	Average frost during the season (total of degrees of frost each day ÷ the number of mornings)	The first day when the grass minimum reached or went below 32, giving the temperature	The last day for above	Lowest grass temperature giving date	Lowest air temperature in shade giving date	Extra data about the last two columns where necessary. g = grass min. a = air min.
1921-22	61.3	21	0	2	10/12(30.5)	7/3(31.8)	27.0 22/1)	37.4(4/1)	g 27.8 on 4/1; a 38.6(22/1).
1922-23	59.3	24	2	3	17/11(31.3)	10/2(31.2)	21.8(2/1)	35.4 2/1)	
1923-24	59.4	39	8	4	15/11(31.9)	19/2 30.9)	23.0 31/12)	35.6 31/12)	
1924-25	58.5	63	17	5	20/11(29.9)	2/3(31.2)	19.9(24/2)	34.7(15/1)	g 21.0(15/1); a 37.4(24/2).
1925-26	58.9	59	16	5	21/11(31.2)	21/2(32.1)	20.9(21/12)	35.3 21/12)	
1926-27	58.4	81	36	7	16/11(30.0)	8/3(27.2)	15.3(11/1)	32.0 11/1)	
1927-28	61.4	26	1	3	23/11(30.3)	18/1(31.7)	23.4(17/12)	37.9 17/12)	
1928-29	59.6	58	12	5	5/12(29.0)	4/3(29.1)	14.7 31/1)	29.0(31/1)	
1929-30	59.2	52	13	5	6/11(30.2)	4/3(31.4)	20.0(7/1)	34.1(19/1)	g 21.3(19/1); a 31.9(7/1).
1930-31	58.4	50	14	6	8/12(24.9)	23/2(27.2)	17.0(25/12)	31.8(23/12)	g 17.3(23/12); a 37.2(25/12).
1931-32	60.6	19	0	2	16/12(31.4)	17/2(32.0)	26.2(30/12)	33.6(30/12)	
1932-33	58.7	32	8	5	8/12(32.0)	30/1(29.8)	20.0(7/1)	30.0(14/1)	g 24.2(14/1); a 31.3(7/1).
1933-34	59.9	34	14	6	14/12(31.0)	8/2(31.0)	20.0(2/2)	39.3(20/1)	g 20.9(20/1); a 32.3 2/2).
1934-25	59.2	27	7	5	20/11(31.9)	27/1(32.0)	19.0(18/1)	27.8(18/1)	

The different data incorporated in this communication will probably remain incomplete if I do not also give a list of all those days in Lahore since 1st January 1879, on which the minimum shade temperature of air went below 30° F. There have not been very many such days during the last half century (to be accurate the last 57 years) and these are set down in Table III.

TABLE III

(showing the days in Lahore since 1879 when the minimum air temperatures went below 30° F.)

Year	Date	Minimum Air Temperature	Grass minimum on the same day
1880	Jan. 19	29.2	18.8
1910	Dec. 23	29.4	17.9
1920	Jan. 31	29.0	14.7
1935	Jan. 15	29.1	21.3
"	" 17	28.1	20.2
"	" 18	27.8	19.0
"	" 19	28.3	20.2

A study of the data included in this paper leads one to the conclusion that very low

air temperatures are not of too common occurrence in the plains of the Punjab whereas quite low ground temperatures are not so uncommon. Really low temperatures seem to result only from actual cold waves; severe ground frosts, on the other hand, do not necessarily mean the incidence or passage of a cold wave.

Low ground temperatures would result from the combined influence of an extremely clear sky and an almost total absence of water vapour in the atmosphere. If the water vapour present is not negligible the ground temperatures may not reach very low figures even though there be a clear sky and, due to a cold wave, below freezing air temperatures. This was perhaps what happened during the last cold wave. On the other hand, absence of any air currents near the ground may be responsible for very low ground temperatures not being accompanied by low air temperatures, there being a difference in level of about 4 feet between the thermometers registering air and grass temperatures.

Another remarkable fact stands out from Table III. During the 50 years preceding

1928, air temperatures (in shade) went below 30° F. only on two occasions, once in 1889 and once again in 1910; whereas during the seven years that have followed 1928, there have been two cold waves resulting in lower than 30° temperatures on one day in 1929 and four days in 1935. One must not really generalise from such meagre premises but it would appear as though we were in for a period of more frequent cold waves!

In the end I must thank the Indian Me-

teorological Department for giving general permission, several years ago, to their officer-in-charge of the local observatory to allow me access to the records, etc., kept in Lahore. And I cannot close without also thanking the local officer, Mr. Dina Nath Chopra without whose active help and co-operation, I would not have been able to maintain my interest in matters meteorological, nor able to give all the facts and figures incorporated herein.

Stigmas and Awns—Their Homology.

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and

V. Panduranga Rao, M.A.,
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THE existence in certain varieties of sorghum of fertile pedicelled spikelets has been noted (G. N. Rangaswami Ayyangar, and V. P. Rao, 1935).¹ One of these varieties, M. S. 1644, is awned. It is well known that in awned varieties the sessile spikelets bear awns and the pedicelled ones do not have them. The occurrence of grain-bearing fertile pedicelled spikelets raised the question whether such fertility resulted in the stimulation and manifestation of the otherwise absent awn in the pedicelled spikelets. An examination of these fertile pedicelled spikelets showed that they did develop the awn concurrent with this fertility—only the expression of the presence of awn was a bit feeble. In Fig. 1 the top picture shows



Fig. 1.

the pedicelled sterile spikelet without awn and in the bottom one the same pedicelled

spikelet when it bears a grain also develops the awn. Where awns did occur, measurements show that they were about half the length of the normal awn: normal—6 mm.; pedicelled—2.9 mm.—(average of 100 readings.) Pedicelled spikelets without awns have occasionally anthers. This activation into a manifestation of the awn concurrent with the appearance of the ovary with the stigma raised the probable homology between awns and stigmas. Looking up literature it was noted that Harlan (1931)² working in Barley "had felt for some years" that the barbs on the awns and the hairs on the stigma arise from the same basic tissue. In 1915 he noticed a high positive correlation between the number of teeth on the awns and the number of hairs on the stigmas. The experience recorded above in which the awn as an organ manifested itself concurrently with the stigma, gives unmistakable proof of their inter-relationship.

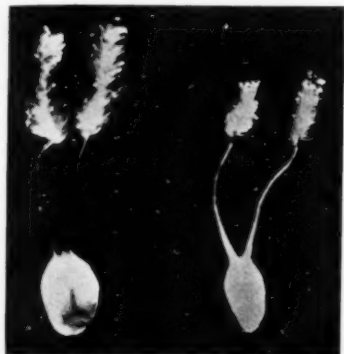
Next to this concurrent presence of stigmas and awns in awned varieties is the parallel that exists in their general morphology. In Fig. 2. are given two stigmas (a) that of *Sorghum Durra*, Stapf, the Grain Sorghum, and (b) that of *Sorghum Nervosum*, Bess, the fodder type, *Irungu Cholan*. It will be noted that in *S. Durra*, the stigmatic feathery cover half the style, and in *S. Nervosum* a little less than a third. Fig. 3 gives the photographs of the respective

¹ *Curr. Sci.*, 1935, 3, 433-34.

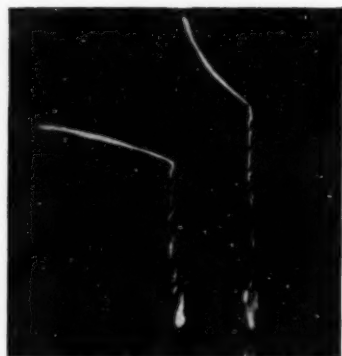
² *Jour. Hered.*, 1931, 22, 271.

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awns and bears out a somewhat similar distribution between the subule and the column. In Table I the relative measurements are recorded.



(a) (b) $\times 7.5$
Fig. 2.



(a) (b) $\times 7.5$
Fig. 3.

TABLE I.

(Average of 100 readings.)

	(1) Length of Style mm.	(2) Length of Stig- matic Zone mm.	Ratio of (1):(2)	(1) Length of Column mm.	(2) Length of Subule mm.	Ratio of (1):(2)
<i>S. Durra</i>	2.0	2.0	1:1	3.5	3.5	1:1
<i>S. Nervosum</i>	2.5	1.0	2.5:1	6.0	3.0	2:1

In Table II are given measurements bearing out the general parallel trend in

the spindle shape of the disposition of hairs and barbs of the two organs.

TABLE II.

	Length in μ			Average of
	Bottom	Middle	Top	
Stigmatic feathers ..	288	452	164	(300 readings)
Barbs in the subule .	42	132	60	(60 ,,)

In Table III, the morphological variation in the longest feathers of the spindle keep parallel to the longest barbs in the awns between varieties.

TABLE III.

	Length in μ			Average of
	<i>S. Durra</i>	<i>S. Nervosum</i>	<i>S. Margaretiferum</i>	
Stigmatic feathers..	555	456	344	(103 readings)
Barbs in the subule ..	180	126	90	(60 ,,)

There are no smooth awned varieties in sorghum; but an African variety, A. S. 3455, manifested the rare phenomenon of irregular feathering, giving the stigmas a chequered featheriness in contrast to the usual good brush they ought to be. This variety was examined and its awn gives the nearest approach to a smooth awn that could be had in sorghum (Fig. 4). An

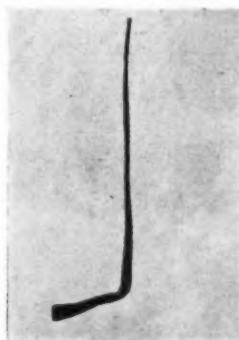


Fig. 4.

$\times 7.5$

enlargement of the normal awn borne on a flower with a normal stigma is given in Fig. 5 and the presence and regularity of the



Fig. 5.

×7.5

barbs in the latter will be patent. The stigmatic feathers of this variety instead of being of the bushy multicellular type of the normal stigma (Fig. 6) were a varying



Fig. 6.

×100

mixture of a few multicellular and many unicellular feathers (Fig. 7). An enlarge-



Fig. 7.

×100

ment of a purely unicellular stigma in this variety is given in Fig. 8. In Fig. 9 is

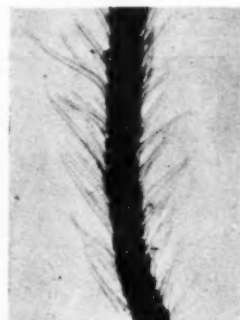


Fig. 8.

×100



Fig. 9.

×100

given an enlargement of the barbs in the normal awn. The resemblance between the two unicellular structures is noticeable.

These parallelisms serve as evidences of the homology between stigmas and awns.

Not all sorghums are awned. There are awnless races, awnlessness being dominant (G. N. Rangaswami Ayyangar, 1934)³. These awnless varieties bear grains and have stigmas. The homology is therefore patent only when the factors inhibiting the expression of awn are absent. It would therefore seem that whereas it is probable that both the awn and the stigma may have specialised from the same basic tissue, their parallel and concurrent specialisation is conditioned by the absence of factors inhibiting the expression of the awn. Genetic factors seem thus profoundly to affect homologous expressions.

³ *Madras Agric. Jour.*, 1934, 22, 18.

Crab-Fishing at Uttarbhag, Lower Bengal.¹

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SCYLLA SERRATA (Forskål) is the commonest edible crab of the deltaic Bengal. It is known as *Samudra Keka* and large quantities of it are brought alive to the Calcutta markets where they command a ready sale, the flesh being greatly relished by the Bengalee population. The species grows to about 8 inches across the carapace and is one of the largest and strongest of the Indian crabs. *Scylla serrata* is widely distributed in the Indo-Pacific region and is abundant in estuaries, backwaters and mangrove swamps; it is also capable of living in fresh water. Stebbing² remarks that "On the muddy coasts of the Bay of Natal, Krauss says, this species lives in great deep holes, and wears the dingy earthy colour

of its residence. They sit at the openings of their holes when the tide is coming to snap up the food which it brings them, and to sun themselves when the tide is going out. At any one's approach they vanish into their holes in a moment, or, if their escape is cut off, they raise themselves up on their hind legs, and by clashing together their powerful claws endeavour to scare away the intruder. By driving a spade into their slanting tunnels their retreat may be cut off, or they will clutch at the proffered point of a stick and may be so drawn out, but the Caffres, who consider



Fig. 1.

A portion of the Hooked-Stick used at Uttarbhag for pulling out *Scylla serrata* (Forskål) from its burrow. $\times 1/7$.

¹ Published with permission of the Director, Zoological Survey of India.

² Stebbing, *A History of Crustacea*, p. 69 (London, 1893).



Fig. 2.

A boy using the implement employed for pulling out *Scylla serrata* (Forskål) from its burrow at Uttarbhag.

them dainty food, capture them by spear-throwing." I have noticed also that at Uttarbhag³ the crab is found in deep burrows along the muddy banks of the Piali Nadi and connected channels at low tides, but the methods employed for fishing it are very different from those noted by Krauss in Natal.

The implement (Fig. 1) employed for pulling out crabs from their burrows consists of a blunt iron hook, lashed to a piece of split bamboo, the length of which depends upon the individual using it. When a crab

³ For description of Uttarbhag and physical conditions prevailing there see Hora, "Animals in Brackish Water at Uttarbhag, Lower Bengal," *Curr. Sci.*, 1933, 1, p. 381.

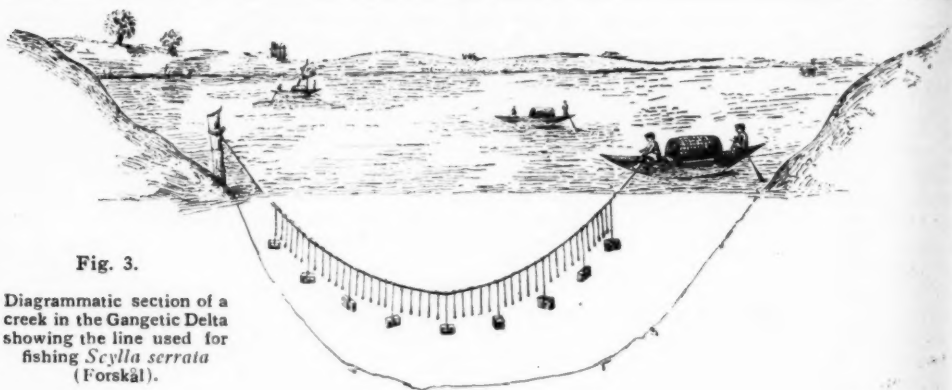


Fig. 3.

Diagrammatic section of a creek in the Gangetic Delta showing the line used for fishing *Scylla serrata* (Forskål).

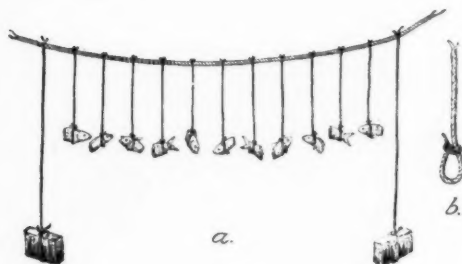


Fig. 4.

A portion of the line used for catching *Scylla serrata* (Forskål). (a) shows arrangement of weights and bait. (b) slip-noose for fastening bait.

hole is located, the hook-end is thrust into it (Fig. 2) and the rod is moved up and down or manipulated in such a way that the crab is hooked and then it is dragged out. The crab sometimes puts up a strong fight and several of its limbs are broken before it can be pulled out and secured in a basket. By this device a few crabs are collected for domestic use.

The commercial method of fishing is very ingenious. A suitable creek is selected and on one bank a thick bamboo is driven into the ground near the water level and one end of a line, which consists of about a quarter inch thick cord, is fastened to it and then the fishermen row to the other bank of the creek and go on releasing the line which is usually long enough to cover the width of the creek (Fig. 3). The other end of the line is fastened to a post in the boat. The line is weighted at regular intervals with half-bricks and in between the weights at short intervals are suspended pieces of fish which act as bait (Fig. 4a). Each piece is secured by a slip-noose (Fig.

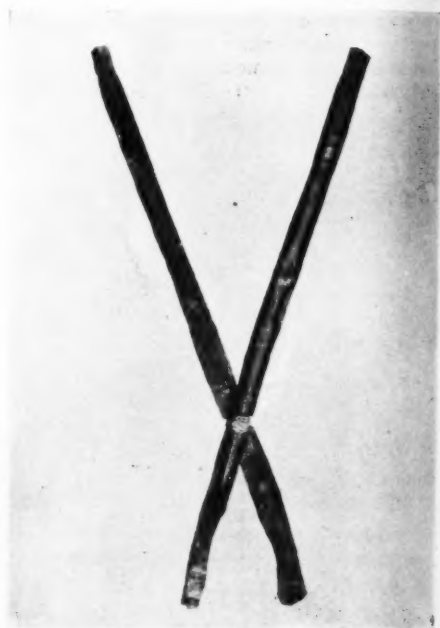


Fig. 5.

A pair of wooden pincers used for holding crabs when counting them for sale. $\times 1/7$.

4b) so that when the bait is pulled, the noose becomes tighter round it. Crabs are attracted to the bait and cling to the line with their strong claws. When the men in the boat feel that a sufficient weight of crabs is hanging on to the line, they begin to pull out the rope. The crabs cling to the bait with great tenacity and are transferred to the hold of the boat which is covered by planking. The weight of the rope is sometimes 50

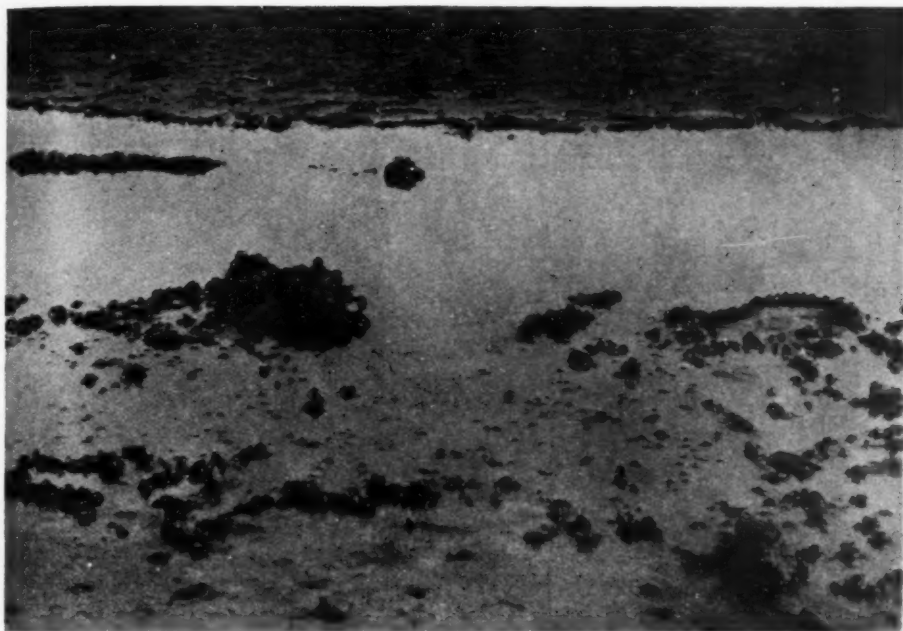


Fig. 6.

Bank of and small islands in a channel crowded with *Varuna litterata* (Fabr.). The small channel runs along the left-hand side of the road to Uttarbhag between milestones 4 and 5.



Fig. 7.

Fishing for *Varuna litterata* (Fabr.) in a small channel along the road to Uttarbhag between milestones 4 and 5.

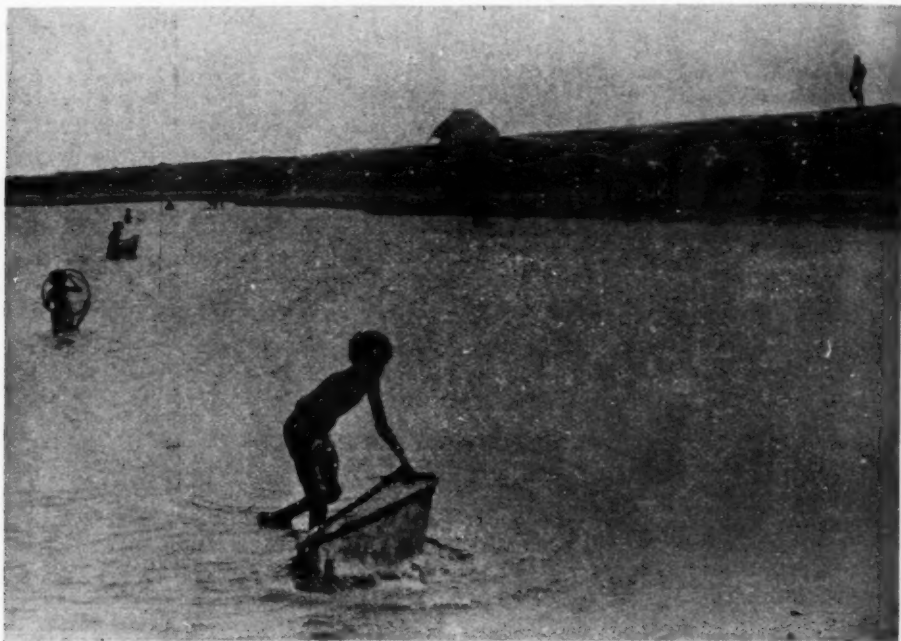


Fig. 8.

Fishing for *Varuna litterata* (Fabr.) in a shallow, vast expanse of water at Uttarbhag. Notice several children fishing in a ring with circular nets.

heavy that 5 to 6 men are required to pull it out of the water. There is usually a small quantity of water in the hold and the crabs are kept alive in it for several days.⁴

The fishermen sell their catch to the retail vendors by quoting the price per score of individuals. The dead specimens are usually given away to poor people as they fetch very little price. In counting the crabs, a wooden pincer (Fig. 5) is used to catch each crab, as the bites of these crabs by their powerful claws are very much dreaded. These crabs are very active and the baskets containing them are securely covered.

The only other species of crab (*Chiti Kekra*) that is fished for food purpose on a small scale, but not for commercial exploitation, is *Varuna litterata* (Fabr.). It is a small species⁵ rarely exceeding two inches across

the carapace. It is found in great abundance and usually lives in burrows along the embankments or sides of pools. During hot months when the pools begin to dry, the crabs collect in wet places, usually in the middle of pools and are fished out by hand.⁶ The real fishing season for these crabs is May-June when large numbers come together and lie along banks and in shallow waters (Fig. 6), presumably to migrate to the lower reaches of the delta for the purpose of breeding. The crabs are simply swept from such situations either with hands or with a small circular, conical net (Fig. 7). Their legs are broken and then they are stored in baskets or small earthen pots. In shallow waters the same type of circular net (Fig. 8) is used and a large number of specimens are collected. *Varuna litterata* is fished for domestic use and not brought even to the Uttarbhag market for sale.

⁴ The boats are of the same type as those used for the trade in "Live Fish"; see Hora, *Jour. As. Soc. Bengal* (N.S.), 1934, 30, pp. 1-15, pls. i-vi.

⁵ For bionomics of the species, see Hora, "A Note on Bionomics of Two Estuarine Crabs," *Proc. Zool. Soc. London*, 1933, pp. 881-884, 2 pls.

⁶ Hora, "Mud-fishing in Lower Bengal," *Jour. Proc. As. Soc. Bengal* (N.S.), 1932 (1933), 28, pp. 197-205, pls. x-xi.

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Atomic Energy States of Tellurium—Te III.

It was previously reported in *Nature*,* that the structure of the spectrum of doubly-ionised Tellurium atom had been elucidated with the help of Vacuum data kindly supplied by Dr. K. R. Rao. Further investigation of the quartz and fluorite regions with a quartz Littrow spectrograph and a Vacuum Grating Spectrograph of the branched-arm type, enabled the extension of the classification to include the higher members of the series such as the 6d, 7s, etc. More than 210 of the observed spectral lines belonging to Te III have been classified. Though there is to be observed in general, a great similarity between the term structure of Tellurium and Selenium yet the considerable complexity of Tellurium spectrum is clear in the magnitudes of the intervals of the corresponding terms. The sp^3 3P term-intervals in Te III, 506.7 and -1549.8 cm^{-1} for instance, are relatively very large compared to the 109

Term	Term value	Term	Term value
sp^3 3D_1	164069.3	6d 3F_2	84217.2
3D_2	153248.7	3F_3	83228.6
3D_3	146308.0	3F_4	78411.3
1D_2	146491.0	1F_3	78883.1
3P_0	150887.3	3D_1	83630.1

Term	Term value	Term	Term value
$7s$ 3P_1	150380.6	3D_2	74992.6
3P_2	151930.4	3D_3	75893.1
3P_0	77058.0	1D_2	80343.6
3P_1	76371.6	3P_0	84607.6
3P_2	68544.1	3P_1	85762.4
1P_1	72457.5	3P_2	76942.8
a	145806.0	1P_1	73385.2
b	154654.1	a	74066.2
c	124833.8		
d	137948.9		
$5p$ 3P_0	246955	$5d$ 3D_1	131215.6
3P_1	242204	3D_2	124444.9
3P_2	238790	3D_3	126058.3
1D_2	229596	3P_0	132668.6
1S_0	215186	3P_1	129165.6
$6s$ 3P_0	139492.9	3P_2	130243.1
3P_1	139237.3	1P_1	119771.4
3P_2	131539.0	$6p$ 3D_1	114838.3
1P_1	132745.1	3D_2	114625.9
$5d$ 3F_2	142246.2	3D_3	107005.3
3F_3	140649.4	3P_0	114692.6
3F_4	138403.9	3P_1	105152.0
1F_3	119713.2	3P_2	107290.5
1D_2	122171.7	1P_1	118337.1
		3S_1	108665.3
		1D_2	103973.1

and -76 cm^{-1} of Selenium. The above is a provisional list of the terms discovered.

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Andhra University,
Waltair,
April 23, 1935.

* *Nature*, August 18, 1934, 134, 255.

A Simple Method for Studying the Magnetic Susceptibilities of Very Small Crystals.

IN connection with some magnetic measurements on organic crystals we had occasionally to work with crystals weighing a tenth of a milligram or less. The magnetic anisotropy of these crystals is not difficult to measure.¹ For the measurement of any of the principal susceptibilities of these crystals, however, the usual methods are not applicable. The following simple arrangement, which we have been using for susceptibility measurements with such small crystals, may therefore be of interest.

Two aqueous solutions are prepared, one diamagnetic and the other paramagnetic with respect to the crystal, both having the same density as the crystal. A suitable mixture of the two solutions is kept in a thin-walled tube of about 2 mm. bore, and a few well-developed crystals are dispersed in the liquid. The tube is placed in the strongly inhomogeneous magnetic field obtaining between the usual conical pole-pieces of an electromagnet, and is adjusted so as to bring one of the crystals to a position slightly below the central axis of the field, equidistant from the two pole-pieces. Watching the crystal through a low-power microscope, and putting on the field, we find that the crystal turns round so as to place its axis of maximum susceptibility along the field, and in general moves laterally also, along the direction of the field-gradient. The relative proportions of the two solutions which make up the mixture are now adjusted such that there is no such lateral movement of the crystal in the field. The maximum susceptibility of the crystal *per unit volume* should then be the same as that of the mixture. The susceptibility of the latter is easily measured.

By changing the inhomogeneous field to a uniform one, and studying the orientations which the crystal takes up, for different initial (*i.e.*, in zero field) orientations, the directions of the principal magnetic axes of the crystal can, of course, be easily located, and the differences between the susceptibilities along these axes studied *qualitatively*.

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S. BANERJEE.

210, Bowbazar Street,
Calcutta,
May, 2, 1935.

¹ Krishnan and Banerjee, *Phil. Trans. A.*, 1935.

The Emission Bands of Selenium.

THE extensive emission bands of selenium have been analysed by Nevin¹ who classifies them into three systems all having the same final state X, and arising in three different excited states A, B and *b* of the Se₂ molecule. The last of these is involved in the well-known strong absorption system investigated by Rosen² and Moraczewska.³ We have photographed these bands as produced in a discharge tube in the presence of Argon. They cover the entire region of the visible spectrum and with the exception of just a few bands which appear to be degraded towards the shorter waves, are all shaded to the longer waves. The present analysis has revealed the fact that all of these bands can be classified into one system due to the transition B→X. The γ green-yellow bands of Nevin are part of this extensive system and therefore there is no evidence for the existence of the level A. About level *b* we are not yet quite definite but very probably the β -diffuse blue emission bands which involve this level will also find a place in the same $v''v'$ table.

Superposed on these bands is a persistent continuous spectrum which must be originating in one of the excited levels, B, C or D and the repulsive curve which arises out of the same constituent atoms that go to form the ground state of the molecule.

The states B and X are supposed to be $^3\Sigma$ levels in analogy with similar terms in O₂ and S₂. Recently, however, Olsson⁴ has shown, from the rotational analysis of some of the bands which form part of the system B→X that the transition involved is $^1\Sigma_u^+ \rightarrow ^1\Sigma_g^+$. If this is true and if the final level of these bands is also the ground state of the molecule as it appears most probable, many interesting deductions will follow.

A study of the absorption spectrum of selenium vapour is also undertaken with a view to elucidate the structure of the Se₂ molecule, which with the existing data of Moraczewska is not possible and a full report will be given elsewhere in due course.

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¹ *Nature*, 1930, 126, 13.

² *Zeit. für. Phys.*, 1927, 43, 69.

³ *Zeit. für. Phys.*, 1930, 62, 270.

⁴ *Zeit. für. Phys.*, 1934, 90, 138.

Note on the Absorption Spectrum of some Organic Vapours.

DURING some measurements of absorption spectra in the Schumann region we have photographed also the absorption spectra of acetyl chloride, acetyl bromide, and trichloroacetyl chloride down till 1510 Å.U. Preliminary results have been used already in an earlier publication of this laboratory¹, but since those figures have been not very accurate, we should like to state the definite results here. The following table shows the

absorption maxima of the three substances at shorter wave-length together with those in the near ultraviolet recorded previously.¹

The first maximum, identical with the point of predissociation known in formaldehyde and related molecules, appears in all these substances. The two chlorides show two more maxima each at shorter wave-length, but in acetyl bromide we have not been able to trace corresponding maxima.

The difference between the two first maxima agrees well with similar differences found by Scheibe and his co-workers² in the

TABLE I.

			I Maximum		II Maximum		III Maximum		Δ II-I	Δ III-II
			AU (air)	cm ⁻¹ (vac)	AU	cm ⁻¹	AU	cm ⁻¹		
CH ₃ ·CO·Cl	..	..	2750	26353	2305	43371	2017	49563	7018	6192
CH ₃ ·CO·Br	..	.	2500	39988	..	..	..	..	..	..
CCl ₃ ·CO·Cl	..	..	2575	38823	2140	46714	1675	59701	7391	12937

case of ethers and alcohols and might be due to the excitation of the radicals CH₃ and CCl₃ respectively. The energy represented by the second maximum appears not to be sufficient to account for the rupture of the double bond of the carbonyl radical. The large difference between acetylchloride and trichloroacetyl chloride seems to exclude a photo-dissociation in which the bonds of the radical and the chloride atom are fissured simultaneously. Therefore this energy difference represents probably an other excitation of one of the radicals; the experimental data are, however, not yet sufficient to decide these questions.

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Muslim University,
Aligarh,
Department of Physics,
May 8, 1935.

¹ Ind. Jour. Phys., 1934, 8, 537.

² Z. phys. Chem. (B), 1933, 20, 283; 1934, 25, 52.

On the Linkage of HCl.

WITH respect to the discussion¹ in *Current Science* on the continuous absorption spectrum and the nature of the linkage in molecules like HCl, HI, etc., I should like to draw attention to the fact, that also other

properties of these molecules have to be considered, since the continuous absorption spectrum is by no means a rigorously valid criterion of ionic linkage. It will be sufficient to mention only two such properties here:—

(i) HCl and HI are not conductors of electricity in the liquid state in the complete absence of water. We can easily conceive that a molecule (AgCl is an example) possesses covalent linkage in the vapour state and electro-valent linkage in solution or the molten state. The converse behaviour, however, would be very difficult to understand.

(ii) According to the wave-mechanical theory of the Raman effect, worked out by Placzek² on the basis of the polarisability of the molecule, a molecule with a single electrovalent bond is not able to show the Raman effect. The molecules HCl, HBr and HI show the Raman effect not only in the liquid state and even in solution in some solvents without dipolemoment, but also in the vapour state. Hence they are covalently linked in the gaseous state, and this agrees with Franck's original conclusion derived from their absorption spectrum.

As to Franck's criterion of the ionic linkage, i.e., the dissociation of the excited term into normal atoms, it has been pointed out by him several times³ that it cannot be

rigorously valid since we know that intersections of the U/r curves of the electronic terms of a covalent molecule among themselves are quite possible. If two such terms, i.e., an attractive and a repulsive one, originate from the same level of the separated atoms, this is equivalent to an intersection for the purpose of the application of Franck's criterion, since it represents an intersection at very large internuclear distance.

To my mind particularly the existence of the Raman effect appears to be decisive and I have therefore treated these molecules as covalently bound in the vapour state in my "Report on Absorption Spectra and Chemical Linkage" contributed to the "Symposium on Molecular Spectra" of the Indian Academy in August 1934, which has just been published and where a discussion of the experimental detail of absorption spectra can be found. There seems to be little doubt that the shift of the red wave limit is due to a different distribution of the molecules among the vibrational levels of the ground term, which is indeed a very common phenomenon. Similar remarks apply to the molecule $N \equiv N = O$ of which we know not only the Raman effect, but also the dipole moment, Kerr constant, etc.

Department of Physics, R. SAMUEL.
Muslim University,
Aligarh,
May 8, 1935.

¹ S. Dutta and B. Chakrobarty, *Curr. Sci.*, 1934, 3, 349, 478; A. K. Dutta, *Ibid.*, 1934, 3, 477.

² *Z. f. Phys.*, 1931, 70, 84; *Handb. d. Radl.*, VI.

³ J. Franck, *Nature*, 1931, 127, 19; Franck and Kuhn, *Bull. Ac. Sci.* (Allahabad), 1932, 2, 223.

On the Ratio of the Temperature Coefficients of Surface Tension and Thermal Expansion.

IN a letter to the Editor of *Current Science* (published in the March 1935 issue, p. 418), Sibaiya shows that the observed constancy of the above ratio can be deduced from Laplace's theory of Capillarity. It is interesting to note that on the experimental side, the constancy follows at once from the observed validity of the parachor law. For we have,

$$\gamma = \frac{P^i}{V^{\frac{1}{3}}} \quad \dots \quad (1)$$

$$\text{whence} \quad \frac{\frac{1}{\gamma} \frac{d\gamma}{dT}}{\frac{1}{V} \frac{dV}{dT}} = 4 \quad \dots \quad (2)$$

Both (1) and (2) follow from a modification of Edser's theory of liquids which has recently been discussed by the author in a number of papers.¹ For on this theory we have

$$\gamma = \frac{\pi \mu}{4(m-5)\sigma^{m+1}} \quad \dots \quad (3)$$

where μ is the coefficient of the attractive force between the molecules, m is the force index, and σ is the average diameter of the spherical space kept clear around a molecule by its thermal movements at T .

The close-packing equation

$$N \sigma^3 = V \sqrt{2} \quad \dots \quad (4)$$

when combined with (3) gives

$$\gamma = \frac{K}{V^{\frac{m+1}{3}}} \quad \dots \quad (5)$$

where K is a constant.

Hence

$$\frac{\frac{1}{\gamma} \frac{d\gamma}{dT}}{\frac{1}{V} \frac{dV}{dT}} = \frac{m+1}{3} \quad \dots \quad (6)$$

(5) and (6) reduce to (1) and (2) if m is put equal to 11.

As shown in Table IV² the observed value of the left hand side of (2) for normal liquids is 3.4–4.2 rather than 2–3 as stated by Willows and Hatschek.³ The wide validity of the parachor law confirms the approximate value 4.

T. S. WHEELER.

Department of Chemistry,
Royal Institute of Science,
Bombay.

April 2, 1935.

¹ *Ind. Jour. Phys.*, 1934, 8, 530.

² *Ind. Jour. Phys.*, loc. cit., 535.

³ *Surface Tension and Surface Energy*, 1915, p. 7.

THE ratio of the temperature coefficients of surface tension and density as derived from the parachor law is 4. Wheeler has shown¹ that the experimentally observed ratio for some organic liquids lies between 3.44 and 4.16, giving for the force index m a value either 9, 10 or 11. Laplace's theory gives for the ratio a value equal to 2; and under special assumptions the ratio becomes $2(1+\epsilon)$. If the parachor value is to be accepted we have to assume that $\epsilon = 1$. Most organic liquids and liquefied gases give a value for the ratio ranging between

3 and 5; an additional list of substances with the calculated values of this ratio from the data given in International Critical Tables is given below :

Substance	$\frac{1}{\sigma} \frac{dT}{d\theta}$ $\frac{1}{\sigma} \frac{d\sigma}{d\theta}$
C_2Cl_4	3.162
C_2H_6O	3.319
C_6H_6O	3.360
$C_6H_5NO_2$	3.007
C_7H_5N	3.298
$\alpha-C_{13}H_{10}O$	3.256
C_6H_{12}	5.340
A (liquid)	4.236
Cl_2 (liquid)	4.153
N_2 (liquid)	3.458
O_2 (liquid)	3.482
H_2 (liquid)	4.671
Br	3.343
Hg	2.290
H_2O	13.2
H_2O_2	2.473
Pb (liquid)	1.055
Bi (liquid)	1.491
Sn (liquid)	0.325

In the above table, there are, however, liquids for which the ratio is considerably different from the value 4 derived from the parachor law. The degree of approach of the experimental ratio to the theoretical value 4 for any liquid can be taken as a test of the liquid obeying the parachor law. Judged from this standpoint, liquid metals, C_6H_{12} , H_2O_2 , H_2O , Hg, and H_2 (liquid) do not appear to behave like normal liquids.

L. SIBAIYA.

Department of Physics,
Central College,
Bangalore,
April 10, 1935.

¹ Ind. Jour. Phys., 1931, 8, 535.

The Effect of Magnetic Field on Electrolytic Conductors.

In January 1934 I observed that the conductivity of aqueous solutions of copper sulphate, potassium permanganate and others, measured by the usual Wheatstone's Bridge method using alternating current of frequency ranging from 300 to 3,000 alterna-

tions per second, did not show any perceptible change even in powerful magnetic fields; but when direct current was used, the electrolytic current flowing through the solution only for less than a second (before the commencement of the evolution of gas bubbles at the electrodes) as measured by a milliammeter, did show a definite decrease when the magnetic field was applied at right angles to the lines of flow of the electric current.

While continuing the investigation of this magnetic effect with a view to find out the exact cause of the change in conduction, another interesting phenomenon was observed, viz., the deflection of streams of fine gas bubbles evolved during the electrolysis of aqueous solutions of several acids, alkalies and salts under the influence of a magnetic field.¹ While continuing and extending those investigations I have obtained the following results:—

(i) The deflection of streams of gas bubbles evolved during electrolysis or in chemical reactions (e.g., action of acids on metals like Fe, Zn, Mg, and of water on calcium) and also of fine streams of solutions of electrolytes or colloids is observed only when both the electric and magnetic fields are acting simultaneously and not separately.

(ii) The same stream of gas bubbles or of electrolytic solution is deflected in opposite directions when brought near the cathode and then near the anode.

(iii) The deflection does not depend upon the chemical nature of the gas forming the bubbles or on the nature of the charged ions contained in those gas bubbles or on the charge at the interface between the gas bubbles and the solution, but it depends on the direction of flow of the current through the electrolyte and the direction of the magnetic field.

(iv) The streams of gas bubbles, etc., are mechanically deflected by the conducting electrolytic solution, which suffers deflection in opposite directions near the anode and the cathode, when placed in the magnetic field. In fact, this deflection of the solution near the electrodes can be rendered visible by suspending in it fine particles which show a rotatory motion in a clockwise and anti-clockwise directions near the two electrodes, when the solution is electrolysed in a magnetic field.

The last observation explains the results obtained by Dr. D. Nider² and also the

phenomenon described above, *viz.*, the decrease in electrolytic conduction in magnetic fields.

A detailed account of this investigation will be published shortly.

K. KRISHNAMURTI.

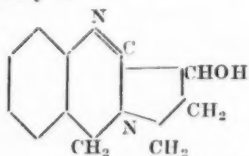
Chemistry Department,
College of Science,
Nagpur, C.P.,
April 29, 1935.

¹ *Curr. Sci.*, 1934, 2, 387.

² *Praktika*, 1931, 6, 130.

Vasicin.

IN continuation of our note on the above subject published in *Current Science*¹ we wish to state that the picronolate of the reduction product of the base II mentioned in that paper, has been found to be identical with the picronolate of reduced vasicin. Therefore the structure of vasicin is linear and is probably I



We had started on the synthesis of I by preparing γ o-nitro-benzyl amino- α -hydroxy butyric acid with the object of closing up the quinazoline ring by reduction with zinc dust and acetic acid after lactamisation but we were surprised to find that Späth, Kuffner and Platzer² have just effected almost an identical synthesis. In view of the position stated by us in *Current Science*³ we thought

that we shall be allowed to complete our work but obviously it is not to be.

K. S. NARANG.
J. N. RAY.

University Chemical Laboratories,
University of the Punjab,
Lahore,
April 29, 1935.

¹ Vol. 3, 352-353.

² *Ber.*, 1935, 68, 700.

³ *Loc. cit.*

2 : 4 : 5-Trimethoxy-1-allyl-benzene.

Asarone (allyl).

OLEFINIC phenols and their ethers are among the commonly occurring and important compounds in the vegetable kingdom. Though asarone (2 : 4 : 5 trimethoxy-1-propenyl-benzene) has been known since 1890, its allyl isomer has not been known, attempts at its synthesis having proved unsuccessful. It is the only allyl isomer among the naturally occurring olefinic phenolic ethers that is unknown. Recently Kelkar and B. S. Rao¹ during an examination of calamus roots found that the volatile oil contained 82 per cent. of a body closely allied to asarone, further purification leading to samples with 85 per cent. The latter could not be induced to solidify, thus showing that it was different from asarone which melts at 67°C. But as it had not been obtained chemically pure no definite conclusion could be reached.

Asarone (allyl) has now been obtained pure by treatment with selenious acid which holds back the impurities and final distillation over sodium. It is converted quantitatively into asarone (propenyl, m.p. 67°C.) by fusion with caustic potash, like other allyl phenolic ethers. The properties of asarone (propenyl and allyl) are as follows :—

	M.p.	B. P.	d	n_d^{20}	(R) _D
Asarone (allyl) (from Calamus oil)	liquid	283/685 mm.	1.078 (d_4^{30})	1.5578	62.2
Asarone (propenyl)	67°C	296/760 mm.	1.165 (d_4^{20})	1.5643	62.7

Its physical and chemical properties which will be described elsewhere are in agreement with its being an allyl isomer of asarone.

Indian Institute of Science,
Bangalore,
May 1935.

B. SANJIVA RAO.

K. S. SUBRAMANIAN.

¹ *Jour. Ind. Inst. Sci.*, 1934, 17A, 29.

Vitamin C Content of Some Indian Plant Materials.

IN the course of a search for a suitable raw material for the preparation of ascorbic acid for the study of its action on catheptic proteases, we have examined a large number of indigenous fruits and vegetables for their content of this vitamin, using Tillmans' method of titration against 2:6 dichlorophenol-indophenol as modified by Harris¹ and by Emmerie and Eekelen.² Some of the results are given in the following table; parallel titrations against iodine are also included, the reducing power being expressed as ascorbic acid.

The experimental findings not only show the existence of strikingly rich sources of vitamin C among materials hitherto not examined, but also throw interesting light on the variations in the conditions in which it exists in plants. Thus the four materials, Nos. 2—5, in the table below give extracts which undergo oxidation very readily as do solutions of pure ascorbic acid. This tendency to rapid oxidation runs parallel with the absence of any considerable amount of other reducing material in the extracts, as shown both by the proximity of the values obtained by titration against the indicator and against iodine, as well as by the small fall in these titres after mercury

TABLE I.

Material	mg. of ascorbic acid per gm. of fresh material			
	Initial Value		Value after mercury treatment	
	Indicator	Iodine	Indicator	Iodine
1 The Indian gooseberry— <i>Phyllanthus emblica</i> Linn. ..	4.13	..	3.65	..
2 Drumstick— <i>Moringa oleifera</i> Lamk. Leaf ..	2.16	2.24	1.92	1.99
3 " " " Pod ..	1.91	2.10	1.01	2.10
4 <i>Sesbania grandiflora</i> , pers. Leaf ..	1.84	2.02	1.64	1.95
5 Chilli— <i>Capsicum frutescens</i> , Linn. Green ..	1.0	1.44	No precipitate with mercury	
" " " Ripe ..	1.67	2.17		
6 Cashew apple— <i>Anacardium occidentale</i> , Linn. Juice (mg. per ml.)	2.03	2.86	1.7	2.05
7 Custard apple— <i>Anona squamosa</i> , Linn. ..	1.03	..	..	..
8 Ber, <i>Zizyphus jujuba</i> Jus. ..	0.84	..	..	..
9 Orange (Sathukudi) ..	0.63	0.70	..	..

treatment of the extracts. Cashew apple and Indian gooseberry, on the other hand, give extracts of considerable stability, the latter in particular retaining its titre undiminished even after a week's standing. In these materials the difference between iodine and indicator titres are appreciable, and treatment with mercury causes the removal of a large amount of reducing material. After precipitation with mercury the extracts become readily auto-oxidisable, so that it would seem that originally they contained a substance or substances protecting ascorbic acid from oxidation and precipitable by mercury salts. It was further observed that lead acetate and trichloro-acetic acid were also capable of removing the natural anti-oxidant present in these juices. The nature of these protective (and perhaps interfering) substances is still under investigation but it was thought advisable to publish this short account of the findings already made,

especially in view of the announcement by Mawson³ of the protective action of animal-tissue extracts on ascorbic acid.

Another point to which attention may be drawn is that the ascorbic acid content of chilli, as well as of other fruits tried, attained a maximum at a certain stage of ripeness, the value being lower both in the unripe as well as in the over-ripe fruits.

M. DAMODARAN.
M. SRINIVASAN.

University Biochemical Laboratory,
Madras,
May 10, 1935.

¹ Harris and Ray, *Biochem. J.*, 1933, 27, 303; Birch, Harris and Ray, *Ibid.*, 590.

² Emmerie and Eekelen, *Biochem. J.*, 1934, 28, 1158.

³ Mawson, *Biochem. J.*, 1935, 29, 569.

The Electrical Transference of Vitamin B₁ in Aqueous Solution.

WE reported¹ in 1931 that vitamin B₁ in a concentrate, prepared from yeast, migrated to the cathode at pH 8.5 in an electric field. This constituted at that time the only direct evidence for the basic nature of the vitamin, which was supported by a mass of indirect evidence. This appears to be now further corroborated by chemical studies of what appears to be the pure vitamin².

Recently, however, Sankaran and De³ have called into question our evidence regarding the electrical transference of vitamin B₁. They state that the vitamin has an iso-electric point at about pH 3.0. Although this was considered highly improbable for a variety of reasons, we have re-investigated this question by subjecting a very concentrated preparation of the vitamin, obtained by the fractionation of an extract of rice-polishings to electrophoresis at pH 8.2, essentially according to the method of Sankaran and De, and have corroborated our earlier observation made at pH 8.5. The vitamin migrated to the cathode as tested biologically with rats. The solution in the anode compartment was completely inactive.

The erroneous conclusions of Sankaran and De are perhaps to be ascribed either (1) to their using a suspension of the international standard—a crude “acid clay” adsorbate—for electrophoresis, or (2) to their relying on the measurement of extinction coefficients for the assay of the vitamin, without checking their results by any of the standard biological methods.

B. N. GHOSH.

B. C. GUHA.

University College of Science,
Calcutta,
and
Biochemical Laboratory,
Bengal Chemical and Pharmaceutical
Works, Ltd., Calcutta,
May 1, 1935.

¹ Birch and Guha, *Biochem. J.*, 1931, 25, 1391.

² Windaus, Tschesche and Grewe, *Z. physiol. Chem.*, 1934, 204, 123.

³ Sankaran and De, *Ind. J. Med. Res.*, 1934, 22, 215, 233.

Observations on the Recent Frost Damages.

COLD waves have become rather of regular occurrence since 1929, and this year (1935)

the almost total loss of a promising harvest, has attracted keen attention from scientific standpoint.

Full meteorological data have been kept up at the Station since June 1932. Table I shows the occurrence of two mild cold waves during the first season.

TABLE I.

Days	Max. (F.)	Min. (F.)	Soil tempera- ture at 1' depth (F.)
1932 December 25 ..	70°	43°	75°
1933 January 22 ..	86°	41°	74°
23 ..	86°	42°	74°
26 ..	76°	42°	75°
27 ..	78°	43°	74°
29 ..	76°	41°	73°

Frost for the subsequent years—1934 and 1935—became comparatively very severe and occurred during the same period, viz., 13th to 21st January. The data for these years are graphically represented in Fig. 1.

Observations on the damage done to plants were made almost immediately after each spell. Thus, in addition to cotton and tobacco in 1933, potatoes, cabbage, castor and papayas also suffered to a certain extent in 1934. The intensive study of this year has yielded more exact data regarding the damage. Thus, Cotton (*Gossypium herbaceum* and varieties), *Nicotiana tabacum* (varieties), *Cajanus indicus* and Soya Beans (*Glycine hispida*) were totally destroyed. Others like *Capsicum frutescens* (varieties), *Ricinus communis* (smaller varieties), *Solanum melongena*, *Solanum tuberosum*, *Lycopersicum esculentum* suffered from 95 to 90 per cent. The rest *Saccharum officinarum*, *Brassica oleracea*, *Cuminum cyminum* were affected to varying extents from 45 to 10 per cent. Amongst the few crops that escaped any injury may be mentioned *Allium Cepa*, *Cicorietinum*, *Linum usitatissimum*, *Triticum sativum*, *Medicago sativa* and *Feniculum vulgare*.

Amongst the orchard and garden plants that have been affected are *Ficus carica* (100 per cent.), *Carica papaya* (90 per cent.), *Mangifera indica* (10 per cent.), *Anacardium occidentale* (50 per cent.), *Musa paradisiaca* (90 per cent.), *Eranthemum bicolor* (100 per cent.), *Jasminum Sambac* (90 per cent.), *Jasminum arborescens* (90 per cent.), *Tabernaemontana coronaria* (45 per cent.), *Rosa* sps. (10 per cent.) and *Micheelia champak* (10 per cent.).

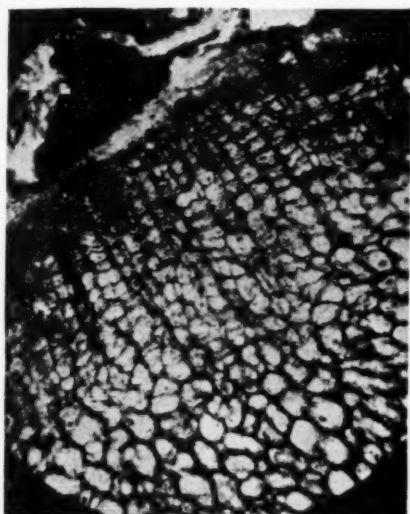


Fig. 2.

Part of the periderm, a dozen cells deep (from the same specimen). $\times 60$.

Early in January I came to know of a paper by Mr. K. R. Mehta, M.Sc., of Benares, describing the root-system of this common weed.⁴ At my request Mr. Mehta very kindly sent me a few of his original sections, which I supplemented by sections cut from plants collected in Lucknow. I was thus able to confirm his observations in the main, although the structure seems more complicated than he describes, and deserves more detailed investigation. The facts, so far as I have been able to gather them from hand-sections, are briefly as follows:

In *A. tenuifolius*, unlike the condition in most monocotyledons, there is one main root (c.r. in Fig. 4) which persists and behaves somewhat like the tap-root of a dicotyledon. The younger roots, whose relation to the main root still needs elucidation, grow vertically down through the cortex of the latter, rather like the intra-cortical roots of a *Lycopodium*. But they soon become so crowded that they begin to distend the main root, which meanwhile has already provided for an increase in girth through the activity of a peripheral cortical cambium (m.p. in Fig. 4). Thus a secondary outer cortex of thin-walled radially arranged cells (comparable to that here described in *Psaronius*) is formed. Some of the later



Fig. 3.

Psaronius infaustus: stem bereft of the intra-cortical root-zone, showing the scars of fallen leaves upon a decorticated surface in the region of the inner cortex. Photograph by A. R. Rao. $\times 3/10$.

formed roots also contribute a little to the girth by partial periderms of their own. But it is a curious fact that these partial periderms are developed only on their outer sides, where they are in contact with the main periderm (p.p. in Fig. 4). The whole appearance strongly suggests that the formation of these partial periderms is induced by some contagious influence (? a hormone) emanating from the main periderm. The newly formed roots sometimes even grow down through the cortex of roots only slightly older than themselves (r.r. in Fig. 4). In a full grown plant a transverse section through the root system may show as many as a hundred or more intra-cortical roots packed round the centrally placed stele of the main root. These roots are as a rule so densely crowded that there is very little room left for any "packing tissue"; but the mode of development leaves no doubt whatever that any traces of such a tissue

that may be left can only belong to the cortex of the main root. At the lower end of the plant the roots are seen breaking through the sheathing periderm, either singly or in thongs of two or more, which become

resolved into their constituents at still lower levels.

I ought to add here that the above interpretation has been confirmed by my colleague, Mr. A. R. Rao, who prepared at

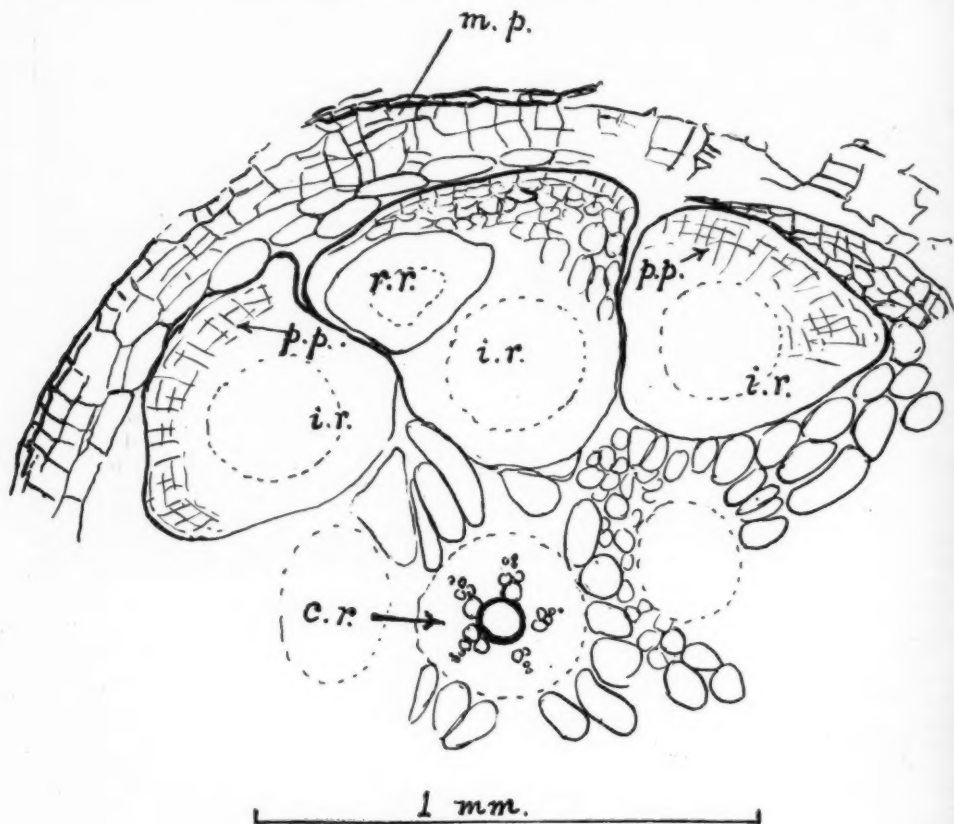


Fig. 4.

Asphodelus tenuifolius. Peripheral part of a transverse section of an old root, with periderms (m.p.), intra-cortical roots (i.r.) with partial periderms (p.p.) on their outer sides; (c.r.) central root; (r.r.) root within root. Camera lucida sketch from a section sent by Mr. Mehta.

my request an independent series of sections. Similarly Mr. V. Puri of Agra, who kindly undertook to prepare some further sections for me, also arrived at essentially the same interpretation.

In presenting this necessarily brief description of the root system of *Asphodelus* I do not wish to claim that we have a complete solution of the *Psaronius* problem. But the discovery of this very unusual mode of growth in a modern plant certainly provides an interesting parallel to the condi-

tion seen in the Palaeozoic genus which has so long puzzled palaeobotanists. Mr. Mehta does not mention *Psaronius*, but the resemblance is obvious and full of significance from our present point of view. It has, at any rate, removed my own misgivings as to the far-fetched nature of Stenzel's interpretation which, without committing myself to details, I am now prepared to endorse. I now have little doubt that the roots in question are truly intra-cortical, although the exact nature of

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the packing tissue is still obscure. Considering all the facts, and especially those brought forward by Solms-Laubach in 1911 (see his Fig. 5, p. 741) it seems the packing tissue in *Psaronius* after all does belong to the roots themselves, as first suggested by Farmer and Hill; although, as Stenzel contends, it was probably of secondary origin. At this point the analogy with the partial periderms of *Asphodelus* is particularly helpful. The true explanation thus seems to lie in a combination of the views of Stenzel, Farmer and Hill, and Solms.

Stenzel's idea that the leaves had fallen before the root-zone was developed is also substantiated by such specimens as the one shown in Fig. 3. Here leaf-scars are visible on a surface (probably in the region of the inner cortex) exposed by the decortication of the inner root-zone; whereas leaf-scars have never been observed, so far as I know, on any surface external to the root-zone.

We thus see that the newly discovered facts strongly support the view of this acute German observer, that the compact root-zone is truly intra-cortical. For us modern workers it is well to remember that Stenzel's conclusions were based not upon an examination of thin sections but only of polished surfaces examined in reflected light.

Once more, the pioneer's work has been vindicated, although it had long been held in question.

A fuller account of the subject here discussed will be published elsewhere.

University of Lucknow,

B. SAHNI.

April 24, 1935.

¹ Proc. 22nd. Ind. Sci. Congress (Botany Sec.), Calcutta, 1935.

² The literature is fully cited in Scott's *Studies in Fossil Botany*.

³ Received in exchange from a private collector (Herr Guldner, a contractor of Chemnitz) during a European tour in 1930.

⁴ Since published. *Jour. Ind. Bot. Soc.*, 1935, 13 (4), 271-275.

Chromosome Numbers in some *Setaria* Species.

NAKAJIMA, GOICHI (1930)¹ records 18 as the somatic number of the chromosome in the Italian Millet, *Setaria italica*, Beauv.

At the Millets Breeding Station, the Italian Millet and some of its allies have been under study for some time. The examination of their chromosomes was taken up.

Three species of the genus *Setaria* were examined, viz., (1) *S. italica* (Beauv.), (2) *S. verticillata* (Beauv.), and (3) *S. glauca* (Beauv.). *S. verticillata* is the familiar burr-like wild ally of the Italian Millet with retrorse barbs on the bristles. *S. glauca* is the *Kavutta* grass of the dry lands of Malabar and the *Korali* of the Nilgiris.

In *S. italica* whose cultivated forms show a wide range of height and vigour three types, viz., (1) Dwarf, (average height 45 cm.), (2) Medium (100 cm.), and (3) Tall (130 cm.) were examined.

The young buds were fixed both in Carnoy's fluid and Allan's modification of Bouin's fluid between 9-30 and 10-30 a.m. Chromosome counts were made at diakinesis and in metaphase plates.

The haploid number of the three species have been determined as follows:—*S. italica*—9 (Fig. 1); *S. verticillata*—9 (Fig. 2); and *S. glauca*—18 (Fig. 3).² The three types of *S. italica* were alike.

In both *S. italica* and *S. verticillata* one pair of chromosomes was found to be much larger than the others as seen in the metaphase plates. The rest of them were more or less equal. In *S. glauca* there were two pairs large and the rest equal to one another. Secondary pairing is evident in this species, showing its polyploid nature. The species is probably a tetraploid one.

The longest diameter of the nucleus (average of 20) at diakinesis of all the species



Fig. 1.
×1852.

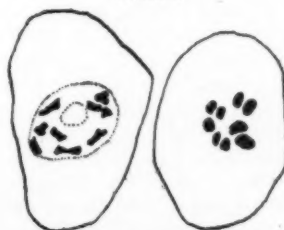


Fig. 2.
×1852.

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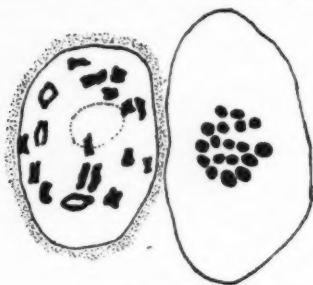


Fig. 3.
×1852.

shows that in *S. verticillata* it is small (4.85μ), *S. italica* (medium 7.45μ), and *S. glauca* (large 12.35μ).

In the classification of the *Setarias*, *S. verticillata* by virtue of its retrorse barbs and articulate fruits has been classed apart from *S. italica*, whereas *S. glauca* is ranged next to *S. italica*. It looks therefore probable that *S. italica* and *S. glauca* form the diploid and tetraploid species of one section of the genus *Setaria*.

N. KRISHNASWAMI.

G. N. RANGASWAMI AYYANGAR.

Millet Breeding Station,
Agricultural Research Institute,
Coimbatore,
April 11, 1935.

¹ *Herbage Abstracts*, 1931, 1, No. 1, p. 2.

² *Madras Agricultural Station Reports*, 1933-34, p. 442.

Some Abnormal Ovules and Embryo-Sacs of *Thylacospermum rupifragum* Schrenk.

LAST year the writer investigated some of the developmental stages of the flower of *Thylacospermum rupifragum* along with the anatomy of its vegetative parts, a short account of which has already been published in a recent issue of this journal.¹ The entire material available in this connection consisted of about fifty fairly old flowers and a few fruits. An examination of them after sectioning yielded some interesting abnormal facts worth recording.

Ordinarily each flower of *Thylacospermum* has in its incompletely bi-locular ovary four campylotropous ovules, each with two integuments, the inner one forming the micropyle. Each of the integuments is two cells thick except for the micropylar and of the inner one which is thicker. In the centre of the ovule there is, as usual in the Caryophyllaceæ

an embryo-sac, lying embedded in a thick nucellar tissue. The fully-formed embryo-sac is an 8-nucleate structure and is almost of the usual Angiospermic type except for a few differences (Fig. 1). In shape it is broad in the middle and tapers towards the two ends. The synergids are laterally hooked and are somewhat larger than the egg cell.



Fig. 1.



Fig. 2.

Thylacospermum rupifragum. 1. An 8-nucleate normal embryo-sac. ×720. 2. A l.s. (Semi-diagrammatic) of the ovary of the flower with ovules which are lobed and contain an unusual number of embryo-sacs. ×52.

The degeneration of the embryo-sac and the nucellus in the ovules seems to be of common occurrence in this plant. Most of the flowers and fruits examined showed either partially or completely collapsed nucellus. The former was found to contain either degenerating embryo-sacs or empty spaces in their place.

One flower was observed in which the integuments and the basal part of the ovules had grown exceptionally large and as such the ovules filled the entire cavity of the ovary. The massive integuments of the ovules were of an uneven thickness and the inner one did not form any definite micropyle as in the normal case. Mostly the top of the nucellus was left uncovered and it rested directly on the wall of the ovary. All the embryo-sacs found in these ovules had degenerated.

Another interesting abnormality was met with in a flower with six ovules inside the ovary instead of the usual four. All the ovules were of a very unusual type. Each of them was comparatively large and very much lobed. It did not show any campylotropous curvature. A very large vascular strand from the placenta entered the base. Each such ovule consisted of almost similar nucellar cells and did not possess any definite

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integument. Fig. 2 gives a semi-diagrammatic representation of this condition as seen in a l.s. of the ovary. In each ovule one or two uppermost lobes were larger and each contained one or in some cases two embryo-sacs. On the other hand, the lobes in the lower part of the ovule were comparatively smaller and sterile. The naked condition of the ovules inside the ovary is comparable to that of the "mamelon" of the Lorantheae. The number of embryo-sacs per ovule varied from one to three. One of the embryo-sacs was found to be 4-nucleate and appeared normal. One 8-nucleate embryo-sac was normal, being similar to a fully-formed embryo-sac of a normal ovule. Three embryo-sacs were 18-, 16- and 4-nucleate and were of abnormal type. The exact position of the nuclei in these could not be clearly made out. Other embryo-sacs were 4-, 8-, 15- and 21-nucleate. They differed widely both from the normal embryo-sac and from one another in their size and shape and the organisation of the nuclei. A full account of them with all the diagrams will be shortly published elsewhere.

PRAKASH CHANDEA JOSHI.

Department of Botany,
University of the Panjab,
Lahore,
April 18, 1935.

¹ Curr. Sci., 1935, 3, 300-301.

An Instance of Reversion of Floral Parts in *Quisqualis indica*.

WHILE casually looking at a plant of *Quisqualis indica* in the Botanical Gardens of the Benares Hindu University, in April 1934, a single large petaloid structure like the sepal of *Mussaenda*, among an inflorescence attracted my attention. On examination, it was found that the whole of the calyx tube of a flower was modified into a single structure like the sepal of *Mussaenda*, without any evidence of a tubular structure at all. This was arising, not from the inflorescence axis, but from the subtending bract, and with the latter, two bracts belonging to two adjacent lateral normal flowers, have also fused by their edges up to a considerable length. On the posterior surface of the single sepal was attached only one stamen with a normal anther.

As for the gynæcium of this flower, there is no trace of it, but just in the axil of this modified structure, is an organ perfectly

leaf-like both as regards colour and general appearance, and is about five times the size of an ordinary bract. This structure has not got any connection with any other flower, and it may be regarded as a modification of the gynæcium.

These abnormalities may be considered as reversions to the foliar nature of the floral parts, although the cause of such a reversion cannot adequately be explained at present. The gynæcium has completely reverted to the leaf-form. The tube-like calyx of the normal flower has been modified to a large leaf-like form, but brightly coloured. This reversion itself explains the fusion of the bract with it, and points to a closer relation to a leaf, because leaves generally do not have any subtending structures.

In the specimen, the basal region of the bracts has been twisted, so that for outward appearance, the posterior side became the anterior, and *vice versa*.

V. S. RAO.

Rajahmundry,
April 29, 1935.

Notes on a Collection of *Paguridea* from Porto Novo.

A COLLECTION of *Paguridea* from the backwaters of Porto Novo and its neighbourhood belongs entirely to the two families *Paguridae*, Dana, and *Coenobitidae*, Latreille. *Paguridae*, Dana, is represented by the three genera, *Diogenes*, Dana, *Pagurus*, Fabricius, and *Clibanarius*, Dana, while the *Coenobitidae*, Latreille, is represented by the single genus *Coenobita*, Latreille.

GENUS, *Diogenes*, DANA.

The following species of the genus are included in the present collection:—

(1) *D. custos*, Fabricius. This is the most common species of the locality and a large number of them have been collected. The members of this species are found to inhabit the shells of as many as twenty-two species of gastropod molluscs.

(2) *D. diogenes*, Herbst. This is not as common as *D. custos*, Fabricius.

GENUS, *Pagurus*, FABRICIUS.

The species belonging to this genus are comparatively rare in the locality and the genus is represented by only two species, mentioned below:—

(1) *P. hessii*, Miers. This is the largest and most brightly coloured species of the collection. Only two specimens have been collected.

(2) *P. punctulatus*, Oliver. This is also large and is characteristically coloured species. Only one specimen is present in the collection.

GENUS, *Clibanarius*, DANA.

The following species of the genus have been collected:—

(1) *C. olivaceous*, Henderson.² This is a very common, small, backwater species of the locality.

(2) *C. longitarsis*,³ de Haan. The species is fairly common, occurring along with *C. olivaceous*, Henderson, from which it can be easily distinguished by the presence of red and blue stripes on the legs and by the absence of any lines on the eye-stalks.

(3) *C. infraspinitus*, Hilgendorf. The species is rare in the locality and only one specimen is present in the collection. This is a fairly large, orange-yellow specimen having a carapace of 30 mm. long and is easily distinguished, by the presence of a strong, conical tubercle on the undersurface of the merus of the chelipedes.

(4) *C. arcthusa*, de Man. It is fairly common in the locality.

(5) *C. aquabites*, de Haan.⁴ It is not common in the locality. Only one specimen has been collected.

GENUS, *Coenobita*, LATREILLE.

The members of this genus seem to prefer heavy, gastropod shells for their abodes. It is represented by the two species specified below:—

(1) *C. cavipes*, Stimpson. Only one large specimen has been collected. It appears to be rare in the locality.

(2) *C. rugosus*, Milne Edwards. It is fairly common; but it does not grow to a very large size. It is easily distinguished from *C. cavipes*, Stimpson, by the presence of a stridulating mechanism on the left palm.

A. RAMAKRISHNA REDDI.

Annamalai University,
Annamalainagar,
April 15, 1935.

¹ The key in Dr. Sundara Raj's "*Paguridea*" (Bulletin of the Madras Government Museum, New Series—Natural History Section, Vol. 1, No. 1, 1927, p. 131) does not include this species.

² The key in Colonel Alcock's "Catalogue of Pagurides in the collection of the Indian Museum" (1905, pp. 42 and 43) does not include the two common South Indian species *C. olivaceous*, Henderson, and *C. longitarsis*, de Haan.

³ Dr. Sundara Raj (vide Bulletin of the Madras Government Museum, New Series—Natural History Section, Vol. 1, No. 1, p. 130) suggests that the

species *C. padavensis*, de Man, which has been recorded by Dr. Henderson (vide Transactions of the Linnean Society, (2) Zool. V, p. 423) from Ram-eswaram might quite likely be *C. longitarsis*, de Haan, since the two species at that time have not been sufficiently distinguished from each other.

⁴ This species has not been recorded from Krusadai Island by Dr. Sundara Raj. It has been recorded from the back-waters of Ennur and is present both in the collection of the Madras Government Museum and in the Fisheries Bureau at Ennur.

The Host of *Eupelmus tachardiæ*, How.

SOMEONE has said, "what I say thrice is right"; acting according to this principle Negi and Glover¹ have repeated for the third time what they asserted twice before.^{2,3} While they stress the point—it is the third time their claim appears in print—, I beg equally to emphasise, thrice have they neglected to bring forth any illustrations or details with regard to the life-history of the insect or any objective information.

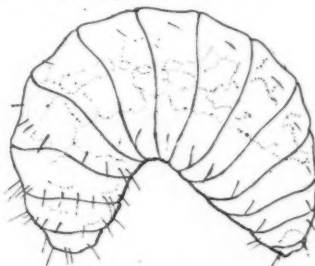


Fig. 1.

Brachemys annulicaudis.

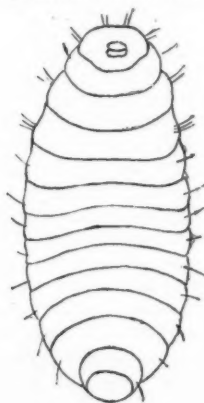


Fig. 2.

Brachemys annulicaudis.

While dissecting the encrustation of *Lakshadia* (not *Laccifer*¹) *mysorensis*, under a dissecting microscope I saw a larva attached to the body of an *Eublemma amabilis* caterpillar. Figs. 1 and 2 were drawn from it but remained as incomplete sketches for the larva pupated the following day, which however enabled Fig. 3 being completed.



Fig. 3.

Pupae of a black Chalcid *Brasema annulicaudis* ♀
Parasite on *Eublemma* caterpillar.

Since the parasitic larva and the host caterpillar were seen *in situ* there was no doubt in my mind of the former being an ectoparasite of the *Eublemma* caterpillar. The only other larva which could have been mistaken for it would have been that of *Microbracon Greeni*, Ashm. (not *M. tachardiæ*, Cam., a name used by Glover and Negi) which was excluded by my having seen its transformation into a pupa. But it may have fed on the larva of this bracon. I had myself suspected *M. Greeni* to suffer from the attack of a chalcid enemy and actually indicated such a probability in the chart accompanying the paper on the insects associated with lac.⁵ However, Negi and Glover have taken no cognisance of this fact. This is said to show I was on the look out for a Chalcid parasite of *M. Greeni* but found no evidence in the above mentioned larva particularly as they mention *Eupelmus* "deposits on the stages of *M. Greeni* only if covered with a cocoon" which could not have escaped notice.

From the studies of lac parasites I concluded⁵ that the lac insects, their parasites, the hyperparasites, and the suprahyparsites are found in decreasing order. Thus when *Eupelmus* is found as a hyperparasite, its immediate host, the *Eublemma* caterpillars must have been found in even larger numbers. Gernet, who first discovered *Eupelmus*, actually found *Eublemma* caterpillars in larger numbers, exactly as the theory anticipates. The negative record, by Gernet, of any bracon excludes *Eupelmus* from acting as a superhyperparasite of lac. Gernet had also found the pupa of the most common internal parasite of lac, *Tachardiaphagus tachardiæ*, How. Thus Gernet's accurate observations are complete in themselves for the two parasites, *Eupelmus* and *Tachardiaphagus* were found together with their hosts, *Eublemma* caterpillars and *Lac* insects. If we grant with Negi and Glover both the parasites were endoparasites of lac, *Eublemma* caterpillars would be assumed as immune, in spite of the large numbers Gernet actually records. My study of the parasites of lac tells me, to increase the hosts in large numbers is to invite their enemies. The parasite of *Eublemma* caterpillars would be a missing link in the insects associated with lac and would be an incomplete explanation, of Gernet's findings. To grant Glover and Negi's explanation of Gernet's records is to admit *Tachardiaphagus* and *Eupelmus* are equally important as endoparasites of lac. If this were so, previous observers would have noticed it and I have found no definite suggestion with regard to host/parasite interrelationship offered by Imms and Chatterjee which proved to be erroneous, and I am not prepared to make an exception in the absence of Negi and Glover having brought any objective information, in their favour. Glover⁶ states his "study of parasiticism and hyperparasiticism is believed to be the first of its kind for an Indian insect" and it is certainly the only amphibious insect known, for it acts as an ecto- as well as an endo- parasite; we are really asked to believe *Eupelmus* has the following hosts: the *Lac* insect—a Coccid, *Macherota planitie*—a Cercopid, *Microbracon Greeni*—a Braconid, *Holcocera pulverea*—Lepidopterous insect, *Tachardiaphagus tachardiæ*—a Chalcid, and *Erencyrtus Dewitzii*, also a Chalcid; the last two are much smaller than *Eupelmus* itself and the hosts belong to three different families of insects. At the time when only one host was indicated and its endoparasitic

nature suggested by its unhappy name, *Eupelmus tachardi*, Clausen⁷ remarked, in ignorance of my positive findings in support of his views, "In Ceylon (*Anastatus*) *E. tachardi*, How. is reported as parasitic upon the lac insect, *L. albizziæ*, but in view of our knowledge of the habits of the genus the record must at present be considered questionable." Glover does not know this objection nor has he ever cited any of my publications. Since my findings fall in harmony with the views of others, including Imms and Chatterjee and Clausen, the burden of proof rather than the comfort of reassertion lies on the side which claims to have done something first of its kind in India and even outside it.

Glover and Negi mention *Marietta javensis* as synonymous with *Microterys Hauteфуilli* and further indicate doubts as to who named the insect. I had myself reared the former insect which I considered of such a minor importance that I never felt called upon to mention it yet. Later on some of my specimens were sent to America where they are found in the National Museum bearing Lot No. 1783, dated 16 February 1929. Some four years ago I created a new generic name and the insect is to be called *Lakshaphagus Hauteфуilli*.⁸ I am here reminded of what the late Prof. Lefroy⁹ wrote, "Indian lac experts seem to be asleep and not to know anything of . . ." the literature on lac, a fact which is most easily demonstrated in the writings of Glover and Negi. Glover and Negi refuse to admit plurality of lac species but if they rear parasites from Chamberlin's *L. rangooniensis* which is a later name for my *L. chinensis*, they would obtain the specific chalcid parasite, *Lakshaphagus Hauteфуilli* and may save themselves the unhappiness of confusing two parasites for one.

With regard to the monophagy of *Eublemma amabilis* they seem to imply it has been known for some time. If so they would cite a concrete reference, rather than make a vague mention. I hope to reply to their other disparaging remarks, after reading the statement, if any.

S. MAHDIHASSAN.

Abid Manzil,
Hyderabad (Deccan),
April 23, 1935.

¹ Negi and Glover, *Curr. Sci.*, 1935, 3, 426.

² Glover, *A Practical Manual of Lac Cultivation*, Calcutta, 1931.

³ Glover, *Bull. 21, Ind. Lac Res. Inst., Ranchi*, Calcutta, 1934.

⁴ Mahdihassan, *Curr. Sci.*, 1935, 3, 365.

⁵ Mahdihassan, *J. Sci. Assoc. Maharaja's Col., Vizianagram*, Oct. 1925, p. 64.

⁶ Glover, *Bull. 21, Ind. Lac Res. Inst.*, p. 9.

⁷ Clausen, C. P., *Annals Ent. Soc. Amer.*, 1927, 20, 470.

⁸ Mahdihassan, *Arch. f. Protistenkunde*, 1931, 73, 170.

⁹ Maxwell-Lefroy, quoted in the Preface to *M. Pidance's Report on Lac Refining*, by Mahdihassan, Osmania Univ. Press, Hyderabad (Deccan), 1930.

Pongamia glabra Leaf Gall Former.

MASSEE in his paper "A new species of gall mite from South India"¹ described the mite, *Eriophyes Cheriani*, on my authority, as the cause of the galls found on the leaves of *Pongamia glabra* Vent. Mani, in his publication entitled "The rôle of the mite, *Eriophyes Cheriani* Mass, in the Cephalonion galls of *Pongamia glabra* Vent."² stated that the mite is "not the true gall maker but only a secondary organism which temporarily inhabits the galls" and "that there is absolutely no doubt as to the gall maker which is a Cecidomyid." In his second publication "A note on the polypoid (Cephalonion) galls of *Pongamia glabra* Vent."³ Mani resiled from his previous statement and stated that "though found in the gall the mite is not primarily responsible for its formation. The gall is originally formed by a minute undescribed Itonidid fly and only certain minor changes in the gall are produced by the mite." In his third publication "Dispersal of gall mites by gall midges,"⁴ Mani stated that "the midges and the mites develop in the same gall for which both of them appear to be responsible." In his latest publication "Studies on Indian Itonididæ,"⁵ Mani reiterated that both the mite and the midge are responsible for gall formation and further stated that "neither of them alone produce such galls."

In view of this controversy and with a view to settle definitely whether the mites by themselves could produce galls, certain inoculation experiments were devised and conducted at Coimbatore. These experiments were so conducted that the experimental plants were free from any Itonidid at any stage. The results of the experiments have been such as to enthrone the mite once more to its former position, viz., the true gall maker. It is not known why in his experiments Mani was not able to get galls by mites. Mites were introduced by me

when the leaves were very tender, almost when these were in the bud stage. If the mites are introduced after the leaves have developed, it is seen, that the galls formed are either very few in number or they will not be formed at all.

Since the Itonidid by itself cannot produce galls as admitted by Mani and since the mite by itself can produce galls as seen from my experiments I think Mani should revise his views and admit that the mites are the true gall formers.

M. C. CHERIAN.

Agricultural College and
Research Institute,
Coimbatore.
March 19, 1935.

¹ *Ann. and Mag. Natural History*, 1933, 11, 201.

² *Ann. and Mag. Natural History*, 1933, 12, 138.

³ *Proc. 21st Ind. Sci. Cong.*, 1934.

⁴ *Curr. Sci.*, 1934, 3, 208.

⁵ *Records of the Indian Museum*, 1934, 36, 427.

Note.—Mr. M. S. Mani agrees with Mr. M. C. Cherman's findings and accepts his results as correct.

A Central Nutrition Board for India.

YOUR editorial in the April number of *Current Science* is much to be welcomed. Several times during the last three years and especially in connection with some University extension lectures delivered at Calcutta in 1932 and lately in connection

with the symposium on Vitamins, held under the auspices of the Indian Science Congress at Calcutta, I had occasion to stress the need for the establishment of a Central Nutrition Board for India. It is encouraging to note that some nutritional investigations are being carried on in India in different laboratories. While it is desirable in the interest of science that there should be some individuality about the researches that are being conducted at different centres, the necessity for a co-ordinating central organisation would appear to be paramount. Such an organisation may be entrusted with the task of (1) co-ordinating the nutritional work of different laboratories, (2) suggesting investigations of practical importance in relation to the varying climates, soils, habits, traditions, availability of food-stuffs, etc., in different parts of the country, and, especially, in relation to the purchasing power of different classes of people, and (3) making the results available to the general public in simple non-technical language.

This board should work in close co-operation with the Imperial Agricultural Council and with the chief medical organisations of the country. It would be a great thing if your editorial can stimulate thought in this direction and lead to the establishment of a committee to go into the proposal in detail.

B. C. GUHA.

P. 109, Lake Road, Calcutta,
May 1, 1935.

The Distribution of a Simple Epidemic Disease.*

By Prof. J. A. Strang,
University of Lucknow.

THE population N being divided into groups v_0, v_1, \dots, v_n in which v_n means the number of persons who have experienced (or are experiencing) an n th attack of illness, it is shown that the numbers v_n are determined by the equations

$$N = v_0 + v_1 + v_2 + \dots + v_n + \dots$$

$$\frac{dv_0}{dt} = -p_0 v_0$$

$$\frac{dv_1}{dt} = p_0 v_0 - p_1 v_1$$

$$\dots \dots \dots$$

$$\frac{dv_n}{dt} = p_{n-1} v_{n-1} - p_n v_n$$

where p_n is the probability that an individual of the group v_n will experience another attack within unit time.

Modifications are suggested for the cases in which

- (i) only a finite number of attacks is experienced by each individual, either because the k th attack is always fatal, or because the k th attack confers immunity;
- (ii) migration occurs during the epidemic;
- (iii) births are included in the reckoning, affecting v_0 , or v_0 and v_1 , according as

* A resume of the lecture delivered under the auspices of the Faculty of Sciences, Lucknow University, Feb. 1935.

- the child of infected parents is not or is infected at birth;
 (iv) individuals are removed by death or otherwise.

If the factors p_n are independent of the numbers v_0, v_1, v_2, \dots the differential equations are linear and homogeneous, and solutions are therefore linearly additive. The bearing of this on the application of results is pointed out when statistics refer, as they often do, to the sum of a number of outbreaks of disease and not to a single outbreak.

2. The equations are integrated in various cases.

(i) When the probability of infection is constant. Application to the occurrence of cancer. A set of statistics is discussed in some detail, and is shown to be better fitted by taking

$$p_0 = p, p_1 = \frac{r-1}{r} p, p_2 = \frac{r-2}{r} p, \dots,$$

where $r=4$ or 5 , and represents the average number of persons in a household. The effect of increased liability with age is estimated and rejected as insufficient to explain the outstanding discrepancy. Probable reasons for the discrepancy.

(ii) Integration when p_n is a function of the time and independent of n ; when a constant mortality rate is introduced; when the general mortality rate and that due to the epidemic are separately allowed for.

Conditions for the existence of a static condition are obtained and interpreted when p is constant.

(iii) Integration when p_n is not independent of the numbers v_n , but is proportional to the number of infective cases, and is therefore given by

$$p = p_0 [v_1 + 2v_2 + 3v_3 + \dots + nv_n + \dots]^t_{t-T}$$

where T is the time during which infection persists after the occurrence of a given case, i.e., the infective period.

Integration by stages when T is constant. The nature of the solution.

The equation

$$\frac{dv}{dt} = p(N-v)[v-V(t-T)]$$

and its exact solution by means of the substitution $N-v = \frac{1}{w}$

First approximate solution. Application to the Great Plague of London.

Second approximate formula valid near the beginning of the epidemic when T is constant.

An approximate solution is obtainable even when T is not constant, by substituting for $V(t-T)$ a mean value k . The solution

$$\frac{v-k}{N-v} = \frac{u-k}{N-u} e^{(N-k)pt}$$

Simplification when N is large compared with u, v, k to $v-k = (u-k) e^{Npt}$.

Application to plague statistics. The evaluation of k furnishes an approximate value of T , and it is shown graphically that the variation of T closely follows changes in the relative humidity of the atmosphere. Effect of temperature and humidity on the rat flea, and its connection with the above.

Exploration of the Sea.

THE report of the delegates of the United Kingdom of the 27th meeting of the International Council for the exploration of the Sea, held in Copenhagen from June 4-11, 1934, contains very useful recommendations for preventing the capture of young fish below the size at which they can be sold at remunerative price for the food of man, thereby assuring a continuity of stock. The regulation of the size of the mesh in the trawl nets and the imposition

of a size limit for food fishes which may be landed for sale, formed important subjects of discussion and the Council stated that with a view to ultimate solution of all questions connected with the exploration of the seas it is essential that each Government should arrange for further observations to be carried out by competent observers not only in research vessels but also in commercial vessels and fish markets.

Research Notes.

The Dutch Cosmic Ray Expedition.

PROF. T. CLAY and his collaborators have published a series of papers dealing with the results of the Dutch Cosmic Ray Expedition, in *Physica*. The results reported are very valuable and interesting. They find that there is not only the magnetic latitude effect but also a magnetic longitude effect ascribed to the eccentricity of the earth's magnetism. They have investigated the variation of the intensity of the cosmic rays with respect to the altitude, the atmospheric pressure and the presence of clouds. The variations in the penetrative power of the rays with the magnetic latitude has also been investigated and the results obtained have been published in the recent number of *Physica* (April 1935).

Heavy Water Plant.

BROWN AND DAGGETT (*J. Chem. Phys.*, 1935, 3, 216) have described an improved type of laboratory equipment for the production of deuterium oxide which operates at a higher efficiency than has been previously reported. The electrolysis of a 3% solution of pure sodium hydroxide is conducted in steel cells of seamless tubing which serve as cathode, the anode consisting of nickel plates. The cells are operated at 100 amperes in four stages, the concentration of the deuterium oxide being 2.5, 12.0, 60.0 and 99% respectively at each stage. The gases generated by electrolysis are as usual made to recombine, and the entire design is explosion proof. The residue obtained in the fourth stage is distilled and subjected to an additional stage of electrolysis. The gases so obtained are mixed with pure oxygen and burnt in a silica jet inserted in a pyrex condenser resulting in the production of heavy water of the highest purity.

M. P. V.

Electrolysis of Extremely Dilute Solutions.

THE literature regarding applicability of the Nernst's law of variation of potential with concentration, $E = E_0 + RT \log_e C$, at very dilute solutions has been contradictory (e.g., Schmid, Vögele and Winkelmann, *Helv. Chim. Acta*, 1932, 15, 393). M. Haissinsky has now shown (*J. Chim. Physique*, 1935, 32, 116) that if careful

precautions are taken about equilibrium conditions, etc., Nernst's law is found to be applicable right down to such low concentrations as 10^{-5} to 10^{-12} n. He has in particular measured by the method of Hevesy and Paneth the critical potential of cathodic deposition of bismuth at these great dilutions, using RaE and ThC as radioactive indicators, and finds a progressive change of potential with concentration in accordance with Nernst's law.

M. A. G.

High Pressure Phenomena.

BRIDGMAN (*Reviews of Modern Physics*, 1935, pp. 1-33) has presented a short account of the theoretically interesting aspects of high pressure phenomena. A simple computation shows that the changes within the atom that take place under pressures attainable at present should be small although appreciable. The nature and magnitude of the interatomic changes are closely connected with the law of interatomic forces. The original theory of Born based on the Bohr atom, the empirical ninth power law and the exponential law emerging from wave-mechanical considerations are all found to be more or less short range approximations, and fail to reproduce the volume changes at high pressures. The study of the variation of the thermal coefficient of expansion with pressure leads one to the surprising result that a system may acquire negative values for entropy at high enough pressures; this is caused by the fact that we are measuring entropy with respect to a system in which atom is an inviolable unit. An examination of compressibility of liquids at different pressures reveals a large amount of "slack" between molecules at low pressures; increasing pressure removes the slack rapidly and the compressibility is high. At higher pressures, when the slack has been removed there remains only the compressibility of the molecules and the "Schottky shrinkage" whence the compressibility is low. The nature of the variation of the thermal coefficient of expansion with temperature shows that the effect of pressure is to make the atom rather than the molecule the individual unit of structure.

There have been a number of speculations regarding the form of the melting point curve at high pressures. They are: (1) the occurrence

of a critical freezing point, (2) a rise of the curve to a maximum followed by a fall, (3) a rise to an asymptotic temperature at infinite pressure, and (4) an indefinite rise with pressure and temperature. The present experimental data tend to support the last prediction.

As regards the polymorphic transition amongst solids there is no regular form for the curve. The only generalisation possible seems to be that it never ends in a critical point, which shows the non-existence of a continuous transition from one type of crystal lattice to another—"a gratifying check on the validity of our picture of the constitution of a crystal"! The solid-solid equilibrium is not a mobile one so that one finds a range of pressures and temperatures over which either of the forms may exist. In the interpretation of these equilibria it is often necessary to assume that the attractive centres are effectively located on projections and not at the geometrical centres of molecules.

Several other properties such as viscosity, conductivity, etc., have been investigated at high pressures, but their theoretical interpretation is beset with difficulties.

Certain fascinating speculations are possible regarding the effects of extremely high pressures as exist in the stars. Matter in such highly compressed state has been shown from astronomical evidence to have a density of the order of 100,000. A theoretical consideration shows that such matter cannot exist in a crystal lattice but it should more nearly correspond to a jelly at ordinary temperatures. The matter as we usually find is confined to a narrow diagonal band rising from near the origin in the extended pressure-temperature plane; on the high temperature side of the band it dissociates to a gas of electrons and nuclei and on the high pressure side it collapses to a "pressure-squash", possibly having neutrons, electrons and protons as the units of structure.

K. S. G. D.

Chemical Properties of Elements 93 and 94.

REGARDING the existence of elements of atomic numbers greater than 92, there has been much controversy. For the correct interpretation of Fermi's results on the uranium bombardment a discussion of the properties of elements 93 and 94 is necessary. Grosse (*J. Am. Chem. Soc.*, 1935, **57**, 440) has deduced the chemical properties of elements 93 and 94 according to the periodic

law and Bohr's theory. There are two possibilities. Either elements 93 and 94 are the highest homologues of manganese and iron respectively and may correctly be termed ekarhenium (En) and ekaosmium (Eo), or they belong to second group of rare earth elements according to N. Bohr. The former seems to be more probable.

Ekarhenium will have valencies up to 7, form the highest stable oxide En_2O_7 which will melt below 375°C ., be reduced by hydrogen at elevated temperatures, form an acid with water and may also be basic with strong acids analogous to uranyl salts. Ekarhenium heptafluoride will be very volatile and will hydrolyse with water. Ekaosmium will also have different valencies up to the maximum of 8. The highest oxide EoO_4 will boil below 200°C ., be a weaker oxidising agent than OsO_4 . The highest halides will be volatile and readily hydrolysable.

According to N. Bohr, somewhere beyond uranium a "second group of rare elements," i.e., elements with similar properties, is to be expected. The additional electron between successive elements will be bound in a lower quantum level and not be available as valence electron. Assuming that the filling of the lower quantum level begins in uranium, uranium would correspond to cerium in the first group of rare earths and elements 93 and 94, also 95 and 96, etc., would all have properties very similar to element 91.

A decision as to the nature of these elements can also be made by calculating the energy levels of the trans-uranium elements.

K. S. R.

Effects of Lactose on Growth and Longevity.

THE nutritive value of lactose has received very little attention in the hands of pediatricians, in spite of the fact that this sugar forms a major constituent of the solids of milks; the solids of human milk contain as much as 50 per cent. lactose. Whittier, Cary and Ellis (*J. of Nutrition*, 1935, **9**, 521) have reported the results of their experiments on the influence of lactose feeding on the body weight and longevity; significant differences between lactose-fed and other sugarfed laboratory animals have been found. Thus lactose caused more rapid growth of young rats than sucrose and the animals, in general, lived longer. Sucrose feeding was conducive to fat accumulation both in rats and pigs. The rate of growth on lactose rations is evidently not accountable on the

basis of stimulation of acidophilic organisms in the lower intestine, since dextrin has not the same influence on growth as has lactose.

B. N. S.

Brains of Deep Sea Fish.

WILLIAM M. SHANKLIN (*Phil. Trans. Roy. Soc., Lond.*, 1935, B. 516) has made an important contribution to our knowledge of the structure of the brain of three deep sea fish.—*Ciaphus dumerili*, *Saurida suspicio* and *Bathypterois articularphenox*. These rare specimens were collected by the Bingham Oceanographic Expedition off the Cat Islands (Bahamas) in 1927. The author gives exhaustive accounts of the various nuclei and fibre paths in the diencephalon and mesencephalon regions of the brain. In important structural details, the three fish differ considerably from one another. The brain in the examples investigated has undergone considerable modifications over the normal teleostean brain. The author states "However, it will be impossible to evaluate the full significance of these modifications until more is known concerning their natural history and until more extensive studies are made on the deep sea fish."

A new finding reported in this paper is that the forebrain bundle, which normally terminates in the region of inferior lobes, passes around the outer edge of pars rotunda and turning dorsally and passing adjacent to the ascending gustatory tract reaches the sensory root of the trigeminal nerve. The author explains this as a mechanism whereby the olfactory impulses of the second and third order are relayed direct from the forebrain to the cranial nerve centres. That the torus longitudinalis is closely associated with the optic tectum is clearly evidenced by its complete absence in the brain of nearly blind fish, *Bathypterois*. The gustatory mechanisms are highly degenerate in the brains of the deep sea fish.

New Secondary Sex Character in Salientia.

In distinguishing sex among *Salientia*, size of individuals and the presence or otherwise of a vocal sac have been largely used. Lately, after an exhaustive comparative study of the larynx, the presence of an œsophageal process was almost made a sex determiner in the female Ranid individuals. Mr. Lin (*J. Morph.*, 1935, 57, 131) having studied 91 genera and 553 species, has come to the

conclusion that a series of connective tissue bands which extends the entire length of both layers of oblique muscle, is characteristic of only the male and he labels it "The Linea Masculina". This is found only in adult males and it is suggested that it may be associated in some way with voice production.

Development of the Sense Organs of the Larva of Botryllus.

C. GRAVE AND G. RILEY (*J. Morph.*, 1935, 57, 185) having studied the development of sense organs of *Botryllus* larva have come to the conclusion that these organs find no homologue in the same of Molgula and Amaroucium. In *Botryllus*, the statolith appears as a single club-shaped cell. The light sensitive organs appear as 5 small filaments, each from a ganglion. These filaments penetrate into a cavity formed in the statolith, which becomes later pigmented.

Hyobranchial Apparatus in Plethodontidæ.

THE plethodontid salamanders are highly specialised individuals and are divided into 16 genera. J. Piatt (*J. Morph.*, 1935, 57, 215) having studied the skeleton and muscles of the hyobranchial apparatus interprets the phylogeny of the family in a slightly different way from what is accepted to-day. Three separate lines are derived from a primitive plethodontid stock; one resulted in the Desmognathus group, the second gave rise to the Stereochilus and Gyrinophilus groups while the third ended in Plethodon and Oedipus groups.

The Origin of Potash-Rich Rocks.

WITH his usual brilliance R. D. Terzaghi has offered a solution (*American Journal of Science*, No. 172, Vol. 29) for the most vexed question in petrogenesis, namely, the origin of potash-rich rocks. He has fully discussed the well-known hypothesis of Bowen where he postulates the reaction between Orthoclase and Anorthite, and the equally well-known suggestion of Vogt for the origin of such rocks. Field examples have been cited to show the production of granites and potash-rich rocks by the intense feldspathisation of sedimentary and metamorphic rocks. Experimental observations of Dettrich and F. W. Clarke have already indicated the increase of potash soda ratio during

the weathering and alteration of rocks and soils. Washington's analyses further show that the devitrification of volcanic glasses tend to increase the potash ratio of the rocks. Therefore Terzaghi's suggestion that the process of feldspathisation is more prevalent than we suppose is a fruitful line of research for petrologists working on the interesting problem of the potash-rich rocks.

Mineral Resources of Rajputana.

AFTER a quarter of a century's detailed work in Rajputana Dr. A. M. Heron of the Geological Survey of India has just now published (*Transactions of the Mining and Geological Institute of India*, Vol. 29, Pt. 4) a comprehensive account of the mineral deposits of that vast area. In the words of the author "Rajputana is not rich in mineral wealth either actual or potential," but yet he has located about fifty minerals including some building stones giving the necessary details for the prospector. It is only coal, sandstone, marble, slate and gypsum that are

being continuously worked, giving employment for a large number of people. Some of the old workings have been stopped due to want of proper transport facilities. Of the other deposits none has any economic importance either present or potential.

The wealth of information contained in the book is so useful, as to make it an indispensable guide to any capitalist undertaking prospecting or mining operation in Rajputana. The author has given copious references of much value and the book gives a complete idea of the economic geology of this area. Since the book has been "designed to those who desire to go to Rajputana to make their fortune or otherwise," a mineral map would have been of much value especially to those living outside Rajputana.

Dr. Heron richly deserves to be complimented for the very valuable and authoritative work which he has brought out for the benefit of both geologists and mining engineers in and around Rajputana.

The Journal of the American Museum of Natural History.

THE December (1934) number of this popular magazine is full of interesting articles. The contribution by R. T. Hatt on the habits of Pangolins of Asia and Africa is a fascinating account of these queer animals which are little known but much misunderstood. These bizarre mammals have exchanged their coat of hair for one of large overlapping scales, and possibly in consequence of their feeding on termites, they have lost their teeth, and if it is compensation at all, they possess powerfully developed claws for dismantling the termites' nests. Like the millipedes, these animals roll themselves up into balls when disturbed and also emit a hissing noise. Their long tongue which is prehensile and is coated with viscid mucus, is an adaptive modification for gathering up large number of ants. Equally interesting is the article on Wild Bees by T. D. A. Cockerell who has recorded the strange nesting and feeding habits of a number of species of solitary and social

bees. Among these, mention may be made of such interesting forms as the peculiar *Nomia*, the large *Megatrichia*, the tiny *Perdita*, the leaf cutting *Megachile* and the long-tongued *Melitoma*. The account of Earthquakes and of the instruments that record these movements, by Chester A. Reeds, has a topical interest and the article on the "Haunts of the Wailing Bird" by Alfred M. Bailey gives a description of not only this but also of other birds occurring in the typical Florida's meandering water-ways.

The January and February (1935) issues of this Journal are as usual full of readable articles. In the January issue, Edwin A. Colbert gives a beautiful account of those grassy plains of what is now Nebraska, inhabited by animals long since extinct. These are brought to life before the mind's eye, by a vivid description of the reconstructed fossils of weird Miocene animals.

Is it feasible to organise and publish a Journal of this type in India?

Jute and Allied Fibres.

By K. Biswas, M.A.,

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ATTEMPTS have been made from a very early period to test different types of fibres allied to jute fibres and to replace jute fibres by fibres of some other species. The fibres allied to jute are well known to cultivators for some time and adulteration of jute fibres of commerce is not uncommon. Commercial people dealing in jute carry on transactions either to their advantage or disadvantage in proportion to their knowledge and experience of distinguishing the genuine fibres of jute from the rest while handling the stuff in the market. Some of the fibres are so much allied to jute fibres that it is by no means an easy task of distinguishing between two or several fibres if mixed up together. Of such fibre-yielding plants may be mentioned *Hibiscus cannabinus* Linn. (Mestapat), an annual or perennial prickly herbaceous shrub. This species is reported to grow wild, east of the Northern Ghats but generally cultivated for its fibres in Chota Nagpur, districts of Meerut, Northern Oudh and extensively cultivated in Central and Southern India. It is also reported that the plant is not uncommon in the lower Himalayas ascending up to 3,000 feet in elevation. In Dacca, East Bengal, the plant forms the chief material in the manufacture of paper. The species is a well known medicinal plant. The fibres of this species are very much allied to jute fibres, and are profusely employed in Bengal for the purposes of or as a substitute for jute in the manufacture of fishing nets and other articles of commerce.

Jute belongs to the genus *Corchorus* of the family—Tiliaceæ. There are about forty species under this genus which are distributed throughout the tropical parts of the world. Out of this total number only eight species are wild in India. Of these eight species again only two species *Corchorus capsularis* L. and *C. olitorius* L. are the chief sources of the supply of fibre-jute or gunny. The jute plant is an annual, erect, tall, little-branched herbaceous shrub. The fibre is beaten out of stems after cutting and retting in water. The above two species of jute (pat) proper are grown chiefly in Northern, Central and Eastern Bengal and are not available in any other provinces of India. The place of jute fibres is generally taken in other provinces by *Cannabis sativa* (Indian Hemp fibre), *Crotalaria juncea* (Sunn-Hemp), *Hibiscus cannabinus* (Deccan or Ambori Hemp) and sometimes *Malachra capitata* (Ran or Ban-bhendi) and *Sida* sp. (Berala). There are two other *Hibiscus* species whose fibres are also closely allied to jute (1) *H. abelmoschus* Linn. (The Musk Mallow) a bushy herb which grows during the rains and flowers in cold season, occurs throughout the warmer parts of India. (2) *H. subdariffa* Linn. (The Rozelle) an annual, glabrous, unarmed herb with purplish stem which is generally cultivated throughout the hotter parts of India. Adulteration of jute fibres with those of *Hibiscus* sp. or identification of one of these fibres as jute fibres appears to be of daily occurrence in commerce.

I have recently had an opportunity of examining such fibres particularly of jute and *Hibiscus* through the courtesy of Mr. M. C. Ghose, the

Chemical Examiner, Customs Department, Calcutta. I offer my best thanks to Mr. Ghose for favour of his placing the authentic materials at my disposal. I understand investigation on a sound footing is likely to be in progress in Mr. Ghose's laboratory. Due to export of various fibres and different kinds of foreign cotton and woollen goods at present pouring in Calcutta markets, the distinction of different qualities of fibres is nowadays gaining considerable state importance.

The writer realises that such an investigation can be best carried out by chemists, physical chemists and plant physiologists. He, therefore, by contributing this article, invites their suggestions for a practical, simple and speedy method of distinguishing various kinds of fibres from genuine jute fibres, and also of ascertaining comparative value of various qualities of genuine cotton and woollen goods from spurious materials. Such a discovery will undoubtedly be of considerable importance to commercial and industrial people of this country. Their work is likely to have a far-reaching value. But in the meantime it might be worth while to report here the results of my examination of jute and Mesta fibres, as also conclusions arrived at from experiments carried out on these two fibres by some of the previous workers.

Macroscopic examination shows that jute fibres are more silky to the touch, very pale brown, finer and more pliable or elastic than those of Mesta fibres which are slightly deeper brown, coarser and harsh. Both are combustible but jute appears to be quicker in catching fire and less resistant to combustion. Mesta fibres seem to support combustion to a certain extent.

Microscopic examination reveals that both fibres are bast fibres and are composed of prosenchymatous cells cohering together in bundles by dovetail arrangement. The thickness of the cell-wall varies at both the tapering acute or acuminate ends in ultimate fibre. By ultimate fibre is meant a single prosenchymatous cell of the bast fibres which might be separated out by maceration. The ultimate fibres of Mesta (*Hibiscus cannabinus*) vary from 1.5 to 4 mm. in length and 12 μ in width at the middle. They are nearly of the same length and width as those of jute, which vary from 1 to 3 mm. in length and nearly 12 μ in width. The thickness of the wall of both the fibres is 4 μ and the lumen is 4 μ broad. But roughness in Mesta fibres is evidently due to the nature of the encrusting substance lignin. Pliable more elastic composition of the cell-wall of jute fibres is due to this difference in lignification which occurs uninterruptedly over the whole area of the cell-wall. The nature of impregnation of the cell-wall in jute is neither true cellulose nor true lignin. It is a compound cellulose peculiar to jute and cereal grass type and in the case of jute it is known as lignocellulose. These lignocelluloses induce formation of Prussian blue in the greenish red solution produced by mixing ferric chloride with potassium ferricyanide. It is on this point, I mean, the nature of lignification, that

Hibiscus cannabinus (Mesta fibre) are of less textile value. Under hydrolysis (*i.e.*, boiling in one per cent. caustic soda, Na_2O) for five minutes, Mesta fibres lost 14.0 and after continued boiling for one hour, 19.5 per cent. of its weight and that under the same treatment jute fibres lost considerably less, *viz.*, 13.3 and 18.6. But what appears to be an important point of difference is, in spite of the slight difference in weight and tension experiment (I mean here the breaking strain) what I may call the steam experiment. Samples of the fibre exposed for two hours to steam at 2 atmospheres followed by boiling in water for 3 hours and again steamed for 4 hours lost only 3.63 per cent. by weight and jute 21.39.

It is due to the nature of lignification that my experiment shows that Mesta fibres are more tough, readily absorb lignin stain than those of jute fibres. Phloroglucin with HCl might exhibit difference of brightness in red colouration

due to the depth and difference of lignification of the two fibres. Variation in moisture contents jute (10.3 per cent.) and pH (*i.e.*, acidity and alkalinity) of ash contents of the two fibres are also good differential tests.

The fibres as found in commerce are mainly bast fibres of bundles separated from the parenchymatous cortical layer. They are firmly coherent together and each bundle is composed of half a dozen to two dozens ultimate fibres which are of, as stated above, normal fusiform type. In transverse section they are thick-walled (due to encrustation of lignin) and polygonal. These allied jute fibres when treated with iodine are brown, deep yellow with aniline sulphate and jute instead of becoming bright red is purple with phloroglucin and hydrochloric acid. Concentrated solutions of alkalis have also a remarkable action on fibres of this group.

Colloidal Electrolytes.

THE study of Colloidal Electrolytes has been engaging the attention of eminent physical chemists, and has attracted considerable interest from the theoretical and technical standpoints during the last twenty years. The term "Colloidal Electrolyte" was first used by Duclaux in 1909 for the class of substances having properties common to typical colloids and electrolytes; and later on the term was applied to various systems such as soaps, dyestuffs, proteins, starches, etc. It is therefore with deep interest that workers in Colloid chemistry and allied branches of science will study the monograph published by the Faraday Society (January 1935) embodying the papers presented for the sixty-first general discussion held by the Society. The discussion was held at the University College, London, from 27th to 29th September 1934 under the presidency of Prof. F. G. Donnan, F.R.S.; and prominent Colloid Chemists from overseas attended the meeting. The subject was discussed broadly under two heads: Part I General (including theory and experimental technique) and Part II (special and technical) dealing with soaps, dyestuffs, proteins, starches and other materials.

Dr. Freundlich in the introductory paper (p. 4)* has pointed out the most significant property which distinguishes a colloidal electrolyte from an ordinary colloid. The former are characterised by the spontaneous formation of colloidal ions as contrasted with ordinary colloids where ions of an active electrolyte are present as necessary impurities. The ion micelles formed as a result of aggregation are responsible for the peculiar properties of colloidal electrolytes. (Osmotic Pressure, Conductivity, etc.) The colloidal electrolytes in general fall under three broad categories: (1) The ion micelles sensible to dilution with the formation of simple ions which can be dialysed (Soaps). (2) Ion micelles sensible to dilution with the formation of simple non-dialysable ions (Dyestuffs). (3) Colloidal electrolytes not affected by dilution (Proteins). The electrical properties of the ion micelles no doubt undergo

profound changes in presence of strongly adsorbable substances.

The electrochemistry of colloids and particularly colloidal electrolytes has been extensively worked out by Pauli and his co-workers (*Electrochemie der Kolloide*, Wein, 1929). The essential idea underlying Pauli's work is that any colloid behaves like an ordinary electrolyte in the sense that its surface is dissociated giving rise to the constituent ions of the solid phase. The so-called ionogenic complex gets fixed to the solid phase giving rise to the charge on the particle. The "gegenions" are the ions situated on the liquid side of the interface. The electrochemical properties of sols of Gold and Platinum (p. 12) have been explained on the basis of the adsorption of complex acids formed during the preparation of the sols.

The problem of deciding the exact structure of the electrical double layer surrounding the colloidal particle has been one of great difficulty. Krut (p. 31) maintains that while the inner layer is formed from the material of the particle itself, the outer layer contributing to the ζ potential may consist of ions from other sources as well.

The question whether lyophobic sols can be considered to be colloidal electrolytes has been discussed at great length by Rabinovitch and his co-workers (p. 50). Their views differ fundamentally from those of Pauli and his school. While Pauli and Valko (p. 20) have assumed that potentiometric methods as applied to colloidal systems give an idea of the concentration of the "gegenions", Rabinovitch maintains (p. 57) that potentiometric methods can only measure the activity of the ions in the intermicellar liquid, which is quite different from the activity of the "gegenions".

It appears to us that a satisfactory theory of the nature of the interfacial layer should take into consideration the activity of the "Charging" ions, the "gegenions", and the ions in the intermicellar liquid. The adsorbed ions contributing to the charge on the particle may be the constituent ions of the solid phase. The binding of such ions to the surface of the particle is usually strong. The "gegenions" held electrostatically by the

* References are to the pages in the *Monograph* (*Trans. Far. Soc.*, 1935, 21, 1-121).

"charging" ions contribute to the charge on the solution side. Under the action of the electric field, the "charging" ions move with the colloidal particles. The ions in the intermicellar liquid do not contribute to the charge on the particles. Regarding the interpretation of the potentiometric results obtained with colloidal systems (e.g., the hydrogen ion activity) the reviewers are of opinion that what they indicate is the hydrogen ion activity of the *entire* system. It is *not* the hydrogen ion activity of the micelle or its "gegenions" or the ions in the intermicellar liquid; but it is the *time* and *space* average of the activity of the entire system. The "gegenions" may vary in their activity from zero (non-ionised electrolyte) to unity (fully ionised electrolyte). The activity of the ions in the intermicellar liquid may be affected by the colloidal particles and the "gegenions", and the calculation of their influence is beset with difficulties. The ζ potential according to Rabinovitch is governed not only by the "gegenions" but also by the ions in the intermicellar liquid.

In discussing the behaviour of colloidal acids on dilution (pH, Conductivity, etc.) Rabinovitch (p. 55) working with V_2O_5 sols comes to the conclusion that the colloidal particles act as reservoirs which furnish acid to the intermicellar liquid as dilution proceeds. The results obtained by one of us (M. P. V. Iyer, *J. Mys. University*, July 1932) with stearic acid sols go to show that the behaviour of colloidal acids cannot be treated in all cases from the standpoint of Rabinovitch. In another paper, Rabinovitch (p. 284) questions the experimental results of other workers (Mukherjee, *Koll. Zeit.*, 1934, 67, 178) in regarding colloidal silicic acid as a moderately strong acid so far as its electrochemical properties are concerned. Though Rabinovitch claims to have prepared colloidal silicic acid possessing neutral reaction and poor buffering capacity, his views are not shared by other workers. Treadwell (p. 299) points out that the colloidal silicic acid prepared by him by electrolysis, shows increased acidity on keeping, which he explains as being due to the polymerisation of the molecules of the acid, and not due to any contamination.

The extension of the Debye-Hückel theory to colloidal electrolytes which is beset with various theoretical difficulties has been tackled by Hartley (p. 31). It is considered unlikely that in pure solutions of colloidal electrolytes, activity coefficients smaller than those predicted by the extended theory of Debye and Hückel or micellar mobilities lower than those predicted will be found. It also follows as a necessary consequence that some kind of association between micelles and ions of opposite charge must occur. Donnan (p. 80) has applied his well-known theory of membrane equilibrium to the determination of molar masses, osmotic pressure and electrovalencies of different colloidal ions.

(a) SOAPS AND LONG-CHAIN ELECTROLYTES.

Soaps as colloidal electrolytes are of profound interest in view of their theoretical and technical importance. McBain and his co-workers have done pioneer work in this field. By measurements of the activity of soap solutions at 90°C., they have shown (p. 149) that they simulate a half weak electrolyte in concentrated solution due to the formation of small ion micelles. In dilute solutions however they exhibit the properties of moderately strong electrolytes. Mrs. Laing

McBain (p. 153) has long been engaged in the correlation of the electrokinetic and electrolytic behaviour of soap gels and curds and has come to the conclusion that the migration of Sodium ions in curds and gels is practically unhindered. She is of opinion that the electrokinetic phenomena in soap gels should preferably be formulated in terms of the directly determinable migration velocity of the colloidal ions. The electrokinetic phenomena persist in such systems to very high concentrations of added electrolyte.

Since published data regarding the physico-chemical properties of solid soaps have been scanty hitherto, Bowen and Thomas (p. 164) have made a detailed study of the solid soaps as come out from the factory. They have correlated the hardness of the soaps to the rate of cooling and to moisture content. The temperature of solidification of the soap has been found to depend on the nature of the fatty acid present. Thus the hardness of the soap can be correlated to the titre of the fat charge. The effect of electrolytes present in soaps in altering their hardness and other properties like their efflorescence has been carefully examined.

Murray and Hartley (p. 183) from an examination of the variation of solubility of long chain salts such as soaps and cetyl sulphonic acids come to the conclusion that a true equilibrium exists between micellar and non-micellar forms. A large change in solubility at a certain temperature range (termed the "Kraft Point") has been ascribed to a large change in the ratio between micellar and nonmicellar forms.

The structure of soap micelles is of utmost importance and has been very clearly dealt with by Lawrence (p. 189). He postulates two main types of micelles: (a) The ion micelles wherein all the polar groups are pointing to the water. A change in concentration does not affect the size of these micelles; (b) The neutral or secondary micelles wherein there is crystalloidal association at the polar groups. An increase in viscosity is possible due to the latter type of aggregation. The phase changes in the micelles such as "Kraft point" are supposed to be due to the breaking up of the secondary micelles. That soap solutions are attacked by atmospheric influences such as oxygen and carbon dioxide has been pointed out by Löttermoser (p. 200) who has shown by careful experimental technique that variations in surface tension of soap solutions are the result of chemical reactions with CO_2 and oxygen at the surface.

Stewart and Bunbury (p. 208) have reviewed the industrial applications of colloidal electrolytes, particularly those newer types of synthetic organic compounds as have pronounced surface-active properties, which are finding wide application in the textile industry. These agents are chiefly the alkylated aromatic sulphonates, sulphuric esters of long chain alcohols, sulphonated castor oil and long chain quaternary ammonium compounds. Their chief applications are as detergents, wetting agents or emulsifiers. Some of these compounds have decided advantages over soaps in so far as they give a soft finish to the goods, and are not precipitated out in hard waters or acid baths.

(b) DYE STUFFS.

The formation of micelles of different types in dye solutions and the size of the particles have been recognised to be of great importance in the dyeing process. Valkò (p. 230) has attempted to

compute the size of the dyestuff particles by the study of the rate of diffusion across sintered jena glass membranes. His results show that acid dyestuffs are molecularly disperse, while the substantive cotton dyes are aggregated to form ion micelles. Congo red on account of its Zwitterionic nature is more highly aggregated in acid solution. The discrepancy between migration of dyestuff ions when freely diffusing and when under a potential gradient has been ascribed to the interionic forces between the ions of the dyestuff and the "gegenions".

Robinson (p. 245) has compared the highly purified dyes with commercial products. As with soap solutions, different types of aggregation in dyestuffs have been observed. Thus the micelles of *m*-Benzopurpurine are found to consist of at least ten particles with 25 per cent. of included sodium; while the micelles of Benzopurpurine 4B are rod-shaped and much larger in size. A study of the conductivity-concentration curves of many of the dyestuffs clearly reveals micelle formation even in dyestuffs like methylene blue which till recently were believed to be molecularly disperse. Morton (p. 262) has pointed out the importance of the colloidal constitution of the dye solution and the fine structure of cellulose fibres in the dyeing process. The pore diameter of viscose cellulose is much larger in the swollen than in the unswollen state. The size of the pore is one of the important factors that determines the kinetics of the dyeing process. The diffusion rate of rapid dyes through cellulose capillaries approaches that of diffusion in water, while for the slow dyes it is only 10^{-4} of the previous one. According to this view, aggregation of dyestuff particles will hinder the penetration of the dyestuff. The presence of small particles is quite essential for dyestuff absorption. Increase of temperature favours dye absorption as it causes a decrease in the size of the dye micelles. The rôle of the electrokinetic potential of the fibres in its relation to the absorption of the dyestuff has been emphasised by Freundlich, Valkò and others in criticising Morton's paper.

(c) PROTEINS.

Elöd and Schachowsky (p. 216) have studied the absorption spectra of mixtures of gelatin and tanning material to elucidate the nature of the tanning process. Using different complex salts of Cr^{+++} and Fe^{+++} they have arrived at the conclusion that the instability of the complex salt determines the tanning action. Regarding the nature of the complexes that are formed between the tanning material and gelatin, experiments with cobaltic hydroxide and gelatin go to show that molecular compounds may be formed as a result of the secondary valency forces on the gelatin particle. Elöd (p. 305) has also pointed out in another paper that the dyeing of protein fibres by acid dyestuffs is as a result of chemical combination. In the case of substantive dyes which are sodium salts of sulpho-acids, their colloidal characteristics must be expected to profoundly influence the dyeing process. 'Loaded' and 'unloaded' silk behave differently towards substantive dyes. The "loading" material hinders the free diffusion of the dye to the silk fibre. The structure of wool is different from that of silk in so far as when the former is stretched the secondary valency forces are oriented along the chain. So wool takes up more dyestuff when stretched than when unstretched. The

intermolecular spaces in the fibres determine the penetration of the dyestuffs. These considerations enable us to explain the relative rates of dyeing of silk, wool and hides.

The Zwitterionic character of proteins has long been recognised, but it has been a moot point whether a protein molecule can be considered as a multivalent ion or whether each charged centre can be considered to be a single monovalent ion. These and other electrochemical aspects of proteins have been tackled by Jordon Lloyd (p. 317). The results so far obtained show that the charged centres in a protein molecule have not that freedom of movement observed with crystalloidal ions like sodium or chloride. The hydration centres and charged centres of proteins are closely related, and any electrolytic influence in which a protein takes part affects its hydration. The tendency of a protein to combine with an acid group is governed by the molecular size of the latter. The size and structure of the molecule as a whole has a strong influence on the physico-chemical property of every one of its active centres. Linderstrom-Lang (p. 324) by electrometric titrations of clupein has lent further support to the idea that the structure of the protein, i.e., every charged centre has its profound influence on the electrochemical properties of the molecule.

Bigwood (p. 335) has studied the diffusion of electrolytes in swollen blocks of gelatin and put forward the interesting view that there is a concentration gradient of the micelles which gives rise to a concentration gradient of diffusible ions in the gel.

Weigert (p. 359) has made quite an interesting contribution on the rôle of colloidal electrolytes in photography. He has adduced experimental evidence to show that the intragranular phase consisting of gelatin particles is light sensitive. The photomicelles so formed have a profound influence on the development of the latent image.

The coagulating effect of metaphosphoric acid on egg-albumin has been made use of by Schofield (p. 390) in the estimation of proteins. He has shown that the metaphosphate ions get firmly attached to the amino groups of the protein, as the nitrogen of the amino group and the three Oxygen atoms of the phosphoric acid form a tetrahedral grouping round the central atom of phosphorus.

(d) STARCHES AND OTHER SUBSTANCES.

Samcey (p. 395) who has done a great deal of work on starches has given quite a useful summary of his work. Starch solutions have a negative charge in contact with water. The phosphoric acid which is invariably associated with starch can be liberated by heating. It has been definitely established that the phosphoric acid is not adsorbed by the starch, nor are there any Werner complexes. All the properties of starch show that it is a polysaccharide ester of phosphoric acid. The synthetic amylophosphoric acids which are dibasic have been shown to be analogous in their electrochemical behaviour to the starch solutions. Thus starch consists of (a) the amylose fraction containing no phosphorus and (b) the amylopectin containing all the phosphorus. The two fractions can be separated by electrodialysis. The abnormally high osmotic pressure of the amylopectin is due to the hydrogen ions present as "gegenions". Electrometric titrations of amylophosphoric acid show two definite inflexions due to the neutralisation of the two hydrogen atoms. The migration

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velocity of the amylophosphoric acid has also been determined. The conductivity of the sol is approximately a linear function of its concentration. There is a divergence between the conductivity of the sol and its potentiometric activity, in so far as the conductivity of the sol calculated on the basis of the potentiometric activity of the hydrogen ions is much larger than the observed value. This is quite a general phenomenon met with in colloidal systems. The viscosity changes of the starch solutions on the addition of electro-

lytes have been attributed to changes in hydration as well as to the electroviscous effect.

In this review, an attempt has been made to present some of the broad conclusions arrived at regarding the theory and applications of colloidal electrolytes. The monograph covering 420 pages of closely printed matter is undoubtedly an up-to-date and useful reference for workers in colloids.

M. P. VENKATARAMA IYER.
K. S. G. DOSS.

Problems of Cereal Rusts in India.*

UNDER the auspices of the Indian Science Congress, 1935, held at Calcutta, a Symposium was held on the Problems of Cereal Rusts in India.

Dr. K. C. Mehta opened the discussion by reviewing his investigations into the rusts of wheat, barley and oats during the last 5 years.

He said that in the absence of alternative hosts on the plains the annual propagation and spread has been cleverly brought home to the continuous presence of viable uredospores in the hills, the spores living on self-sown wheats, barley and oats. The infection has been traced to the winds becoming laden with spores and the spores being carried long distances by upper currents of air. In the hills barberries and *Thalictrum* have been found infected with rust but the disease appears much after the appearance of rust on wheat.

The various devices for exposing slides at high altitudes invented by Dr. Mehta and Mr. Chatterji were then explained, and the time of the spread of viable rust spores correlated with the appearance of rust in the fields. There was striking correlation. The different physiological strains of rusts met with in India are few in comparison with those met with in U.S.A. and this was explained because the fungus could not intensively hybridise in absence of secondary or alternative hosts.

The annual loss due to rusts is enormous; control measures are breeding resistant varieties and effort to eradicate the disease in hills by suspension of wheat crop and vigorous destruction of the diseased material.

Dr. F. J. F. Shaw then read a paper by Dr. B. P. Pal on wheat rusts from the viewpoint of plant breeding. Dr. Pal emphasised that the only effective way to overcome the disease problem is by breeding resistant varieties. This is difficult in the case of wheat as the commercially desirable varieties and those possessing the highest measure of rust resistance belong to two different groups the members of which do not readily intercross. Further complexity is introduced by the existence of a large number of physiologic forms of the three wheat rusts and a variety resistant to some forms is usually susceptible to others.

He pointed out that along with these difficulties certain hopeful features exist such as the fact that a single genetic factor sometimes determined resistance to a group of physiologic rust forms and in that certain varieties which are susceptible

in the seedling stage under greenhouse conditions later on develop in the field what is known as mature resistance, the latter being probably morphological in nature. Thus certain varieties appear to be resistant because the bundles of chlorenchymatous collenchyma in which the rust mycelium develop are small and separated by sclerenchymatous fibres. Again some varieties showing mature or field resistance probably owe their resistance to the fact that they open their stomata only after the morning dew has dried up so that germinating rust spores are killed before a means of entry is offered to them.

In conclusion Dr. Pal briefly mentioned the work being carried on in other countries and made some observations on the possibilities of breeding rust resistant wheats for India.

Mr. Burt said that he saw the Indian and European barberries growing side by side at Dr. Mehta's Simla laboratory and found that Indian barberries were resistant while foreign ones were susceptible. He thought that the question whether an embargo should be placed on importation of foreign strains would have to be considered, but, in the meantime, it would be very useful if systematic botanists throughout India would bring to the notice of the Imperial Council of Agricultural Research any instances of imported barberries being grown as ornamental plants or otherwise, so that the Council might see whether susceptible forms already exist in the country.

Mr. P. K. Dey said that while appreciating the great advance in the knowledge of the rusts brought about by the researches of Dr. Mehta, he could not be quite convinced of the disease being due only to the wind borne infection from the hills. He asked why lower leaves were affected in preference to top ones which received highest infection as the infection came from above? Also why was the whole field found to be simultaneously affected instead of random areas as would be presumed from the mode of infection. Possibility of the spores remaining dormant in the soil nutrients should not be completely abandoned. Protected and non-protected fields should be laid to prove definitely the mode of infection.

Dr. H. Chaudhury said that he had noticed a peculiar case at Lyallpur. Two distant plots of Australian wheat were found to be affected with rust but the indigenous varieties of wheat growing by the side of these plots had been found to be quite healthy. Did such cases normally occur?

Dr. Ramdas asked why emphasis was placed on upper layers of the air currents as being the

* The full proceedings will be published by the Indian Science Congress Association in due course.

carriers of the spores instead of the lower layer? Lower layers should not be neglected in such problems.

Dr. Nehru suggested that the electric cultures might be useful in checking the disease. A baby cine on a flying machine may be useful in collecting data of the spore distribution in the upper layer of the air.

Dr. Bagchi said that there should be more intensive research in differentiating physiological forms. At present very small difference was deemed sufficient for forming a new strain. This practice should be discontinued and only after detailed study and recurring major differences should the division into physiological strains be made.

Dr. Mehta replied to the various points raised in the debate and said that he was not prepared to affirm at this stage that the alternate hosts had no part in the annual cycle of black and brown rusts. Circumstantial evidence, however, showed that the air currents laden with uredospores from the hills were mainly responsible for the disease in plains of India.

That loss of viability of uredospores was complete in the plains has been shown by experiments at his research station. Seed borne infection was non-existent. Greater humidity near lower leaves favoured spore germination; hence these are attacked in preference to top leaves. Differential host studies are in progress.

S. V. DESAI.

Easter Session of Scientific Societies, held at Bangalore. 18th—22nd April 1935.

WELCOME ADDRESS.

IN welcoming the delegates, Dr. Gilbert J. Fowler emphasised the need for co-ordinating the forces and facilities at our disposal and referred to a formal agreement between the London Chemical Society, the Institute of Chemistry and the Society of Chemical Industry to set up a body to be called the Chemical Council. This was to consist of representatives of the three bodies, together with representatives of industry nominated by the Association of British Chemical Manufacturers. The object of the Chemical Council was to administer a joint fund for such common purposes as the maintenance of a library and for the co-ordination of scientific and technical publications.

He briefly indicated the characteristic activities as he saw them of the various bodies represented at the session. Few words from him were needed to support the high aims of the Indian Academy of Sciences with its President Sir C. V. Raman. It knew no limit to its scientific activities and strived to scale the peaks of human knowledge. Many of its publications were beyond the present understanding of the lay public who were content to await with interest the news brought from those high altitudes.

The Institute of Chemistry of Great Britain and Ireland concerned itself with maintaining a high scientific and professional status of the chemical profession throughout the British Empire, by holding examinations and by scrutinising very carefully the claims of applicants for its Associateship or Fellowship.

The Indian Chemical Society (Madras Branch) looked after the interests particularly of Pure Chemistry in India, a worthy daughter of the present Chemical Society of London.

The comparatively new science of Biochemistry was represented by the active body known as the Society of Biological Chemists, India, having its headquarters in Bangalore where it was a matter of pride to him that Biochemistry was first systematically taught in India.

Finally, he referred to the South Indian Science Association which fulfilled a very useful function in holding meetings for the discussion of matters of scientific, technical and general importance, but which could hardly find a place in more purely specialist societies. In this way it should serve as a very necessary link between the more recon-

dite activities of scientific laboratories and their exposition to the general public.

INAUGURAL ADDRESS.

In the course of his inaugural address, Sir C. V. Raman referred to the possibility of classifying the main species of nacreous shells on the basis of their internal structure as revealed by the nature and distribution of the halos when they are examined by transmitted light. The X-ray studies of the shells carried out in the laboratory supported the above results.

The reflection colours of nacreous shells, classified into transferable and non-transferable types by Brewster, were in fact found to be due to one and the same type, the result of diffraction phenomena. Microscopic examination revealed the intersections of the oblique layers of the material of the shell at the surface, which was responsible for the intense and variegated colours observed.

RECENT ADVANCES.

Structure of Molecules: Dr. M. A. Govinda Rau.—An important consequence of the newer wave-mechanical theories of the structure of molecules is that the actual state of a complex molecule cannot be represented in general by a single chemical formula but only by a superposition of several states. These states have frequently nearly equal energies and on account of their superposition give rise to an energy of resonance and hence to a stability. There are other consequences of resonance, such as on the dipole moment and notably on the steric properties of molecules. The application of wave-mechanics has been generally very successful in explaining several of the finer details of structure of molecules.

Chemistry of Rubber: Mr. B. Sanjiva Rao.—After briefly referring to the work of Faraday and Tilden who established the relation of rubber to isoprene and of Weber and Harries who developed methods for its purification and studied many of its reactions, the recent work of Staudinger and Pummerer was reviewed. They improved the methods of purification and showed that rubber owes its characteristic properties to its chief constituent the rubber hydrocarbon and specially Staudinger by his fundamental work on the viscosity of high molecular weight substances showed that rubber consists of very long molecules in which over 1,000 isoprene molecules are bound

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by means of main valencies into chains. The elastic properties are closely associated with the length of the chain. The saturated rubber obtained by hydrogenation is also elastic and is stable in air unlike the ordinary rubber which becomes brittle being attacked by oxygen. A reference was made to the excellent synthetic rubber from 2-chloro-butadiene and the great impetus which synthetic rubber research would obtain from Staudinger's work.

Colloid Chemistry of milk in relation to infant feeding and humanisation: Mr. M. Sreenivasaya.—The condition of the casein micellæ in its natural environment varies with different milks, the degree of its dispersion and its state of hydration being largely influenced by the content of (1) Lactalbumin, (2) the non-protein nitrogen and (3) the other crystalloidal constituents like lactose and salts. Milks having higher percentages of the components, in general, exhibit a higher degree of dispersion of their suspensoids and emulsoids and are more easily digestible. The fact that the digestibility of cow's milk can be enhanced by the addition of 0.5 to 1.0 per cent. urea, is a significant advance in the humanisation of milk.

The problem of humanisation was not merely a question of reduction and stabilisation of the colloidal particles of milk. The nutritive value of the dispersing and stabilising agents had to be considered in that connection. Attention was drawn to the limitations of humanisation imposed

by an imperfect knowledge regarding the composition of the caseins and lactalbumins from various milks.

ORIGINAL PAPERS.

21 papers were presented before the Session:—Physics, 8; Inorganic and Physical Chemistry, 4; Organic Chemistry, 2; Biochemistry, 1; and Industrial Chemistry, 3.

PUBLIC LECTURES.

Rao Bahadur Prof. B. Venkatesachar, M.A., F.Inst.P., gave a Lecture illustrated by lantern slides on "Transmutation of Elements", a subject of great theoretical importance. Dr. V. K. Badami delivered an address on "Sugarcane in Mysore", a subject of high economic interest. The lecturer exhibited several specimens of improved canes.

SOCIAL EVENTS.

Sir Venkata and Lady Raman were "At Home" to the delegates and the elite of Bangalore, on the 18th April. On the 20th April, there was another "At Home" arranged by the Societies participating in the Session, at the premises of the Industrial and Testing Laboratory.

VISITS.

Visits were arranged to the Government Transformer Factory and Government Industrial and Testing Laboratory. A whole-day excursion was also arranged for visiting the Mysore Iron Works, Bhadravati. At all the places excellent arrangements were made for the reception of the delegates.

Science Notes.

A Study of the Boundary Lubricating Value of Mineral Oils of Different Origin. (Lubrication Research Technical Paper No. 2. H. M. Stationery Office, Price 9d.).—This Report discusses the results of a more extended investigation on the lines described in Lubrication Research Technical Paper No. 1. That paper attempted to analyse the properties of commercial lubricating oils under boundary conditions but as two oils only (of unknown origin) were employed it was thought unsafe to base general conclusions on the results. In the present investigation oils of known origin have been employed and their properties as lubricants under boundary conditions have been correlated with what is known of their chemical constitution, particular attention being paid to the influence of wax. The results of a few preliminary experiments on the specific effect of the bearing surfaces are discussed.

The Evaluation of Glare from Motor Car Headlights. (Illumination Research Technical Paper No. 16. H. M. Stationery Office. Price 1s. 6d.).—The present paper applies the results of previous research undertaken by the Illumination Research Committee, to the practical problem of assessing the actual glare arising from powerful motor car headlights. By the method described in the paper a "figure of merit" with respect to freedom from glare can be obtained for any proposed headlight system. No attempt is made in the paper to lay down an ideal distribution of light nor to prescribe an actual anti-glare headlight. The practical aim is to help designers of headlights and others interested to assess the merits of

various distributions of light, without necessarily having to construct actual headlights to produce such distributions.

Atmospheric Pollution (Twentieth Report). (H. M. Stationery Office. Price 5s.).—Smoke pollution affects us in many ways—the cleanliness of our homes, the air we breathe, the state of preservation of our historic and other buildings, the sunlight we enjoy and so on. Data regarding deposited impurity, suspended impurity, destructive gaseous impurity, obstruction of light are therefore of close interest. It is the purpose of the investigation of Atmospheric Pollution, the Twentieth Report of which is now available, to supply such data.

Scientific Results of the Dutch Expedition in Karakorum and the neighbouring areas in the years, 1922, 1925 and 1929-30.—The first volume which has recently been published, comprises the scientific results dealing with Geography, Ethnography and Zoology collected during Dr. Visser's three expeditions. The results referring to the other branches of science will be incorporated in the subsequent volumes. According to a notice appearing in the *Sunday Statesman* dated 31st March, the most thrilling pages of the book will possibly be those in which Dr. Visser describes the history of the discovery of Karakorum with dramatic simplicity. Mrs. Visser has given an account of her Ethnographical studies. Dr. Sunder Lal Hora of the Zoological Survey of India, has described the 418 specimens of fishes collected by Dr. Visser and his friends. 87

specialists have contributed to the first volume making it a scholarly production of great importance.

Mount Everest Expedition.—A fresh attempt to scale the Everest is to be made this year by a British Expedition under the leadership of Mr. Hugh Rutledge.

Mount Everest was 'discovered' by trigonometrical calculation 80 years ago. The first attempt to scale the peak was made in 1921 by Lieut.-Col. C. K. Howard Bury. In 1922, General Bruce with a party of experienced mountaineers reached a height of 27,300 feet only 2,000 feet remaining to reach the peak: with the experience gained in this attempt, General Bruce made a second attempt in March 1924 but unfortunately this too proved unsuccessful and the leader and also Mr. S. L. Mallory, another experienced mountaineer, lost their lives. 8 years later Mr. Hugh Rutledge led an expedition and reached a height of 28,000 feet, about 1,000 feet below the summit. Owing to the difficulty of negotiating the rocks covered with loose snow this attempt too proved futile. In the same year four British airmen flew over the peak at a height of 35,000 feet. They have taken a number of photographs and made several important observations and these are now available to the experienced leader, Mr. Hugh Rutledge, who is shortly to make another expedition this year.

The All-India Modern History Congress will be opened by the Governor of Bombay, at Poona on June 8th. Dr. Shafaat Ahmad Khan has been elected President. A historical exhibition has been organised and tours to places of historical interest will be arranged for the delegates during the session.

The International Congress of Neurology will be held in London from July 29th to August 2nd.

The seventh International Congress on Industrial Accidents and Diseases will be held at Brussels, Belgium, from July 22-27.

The tenth Congress of International Society of Surgery will be held at Cairo from December 30th to January 4th, 1936, under the presidency of Prof. A. Von Eiselsberg of Vienna.

The fourth International Congress of Agricultural Industries will be held at Brussels from July 15-27.

Professor Kenneth Aston of Cardiff has been appointed Professor of Electrotechnology, Indian Institute of Science, Bangalore.

Dr. Ziauddin Ahmed, Member, Legislative Assembly, has been elected Vice-Chancellor of the Aligarh University.

The Syndicate of the Annamalai University has appointed Dr. S. N. Chakravarthi, Professor of Chemistry, Annamalai University, temporary Vice-Chancellor, in the place of Mr. S. E. Ranganathan, on his retirement.

Dr. R. P. Paranjpye, whose term of office as Vice-Chancellor of the Lucknow University, expires on September 15th next has been re-

appointed Vice-Chancellor for a further period of three years.

The Director of Industries and Commerce, Government of Hyderabad, invites applications from *Mulki* candidates for 3 scholarships for 2 years for training in Sugar Technology at the Harcourt Butler Technological Institute, Cawnpore.

It is understood that permission has been granted to Professor W. Norman Brown, Professor of the American School of Indian and Iranian Studies and Director of Fine Arts in Boston, for archaeological excavations in Sind. The excavation work is expected to commence during the next autumn.

Mr. H. G. Champion, M.A., F.E.S., Silviculturist, Forest Research Institute, Dehra Dun (India), is leaving India for 8 months, on leave. Mr. M. V. Laurie, F.E.S., will officiate in his place during the period.

From Moscow comes the announcement that before the close of the year a rocket aeroplane capable of flying at terrific speed will be piloted through the rarefied air of the stratosphere. The result of the experiment will be watched with the greatest interest as the possibility of using rocket-propelled machines for flying in the stratosphere, with the idea of eventually reaching the moon is being talked about by a large number of scientists.

Dr. H. W. Dudley, Biochemist, Medical Research Council and Dr. Chassar Moir, London University Gynaecologist, have isolated an alkaloid from ergot, named ergometrine, which produces strong contractions of the uterus after 8 minutes, if administered orally, and within 4 minutes by hypodermic injection.

Hydrogen of atomic weight 3—tritium—, the evidence for which was obtained by nuclear disintegration processes at Cambridge and at the Palmer Physical Laboratory, Princeton, has now been produced by Dr. P. W. Selwood of the Frick Laboratory at Princeton by the electrolysis of 75 tons of water over a period of 1 year. 0.5 c.c. of the precious fluid has thus been obtained. This type of hydrogen exists in a concentration of 1 part in ten thousand million parts of ordinary water.

The taste of 'heavy' water.—Professor H. C. Urey and Dr. S. Failla who have compared the tastes of 'heavy' and ordinary distilled water conclude that the pure deuterium oxide has the same taste as ordinary distilled water. The 'dry' burning taste experienced by Professor Hansen, of Oslo, on tasting 'heavy' water thus remains unconfirmed.

In the course of an article on "Animal Husbandry in India," appearing in *Statesman*, 30th March, Col. A. Oliver, Animal Husbandry Expert, Imperial Council of Agricultural Research Department, stresses on the need for organising Animal Husbandry Departments in every Province and State, "devoted solely to the interests of livestock and capable of carrying on systematic disease investigation and control and of giving

effective assistance and advice to villagers throughout the country in such matters as expert selection and registration of improved stock combined with better feeding of females and young stock; the proper selection and care of suitable sires combined with systematic castration of inferior males; and in the disposal of their stock and produce." In the past, there has been no organised effort and there has been none of that continuity from generation to generation without which no lasting progress can be effected in livestock improvement.

In the course of his presidential address delivered at the annual meeting of the Indian Chemical Society (Punjab Branch) Prof. Ruchi Ram Sahni dealt with "The Place of Science in Mass Education", a subject of very wide appeal. He outlined the constructive proposals for rationalising the education of pupils so as to make them well fitted for life. At home and at school, boys and girls should, throughout, be imbued with the spirit of science and the training should be so designed as to inculcate in the child a distinct bias in the direction of a proper scientific appreciation of facts and principles with which he may be brought into contact in the course of his studies or observation. "No subject of instruction is capable of exciting, stimulating and satisfying the same variety of tastes and interests and bringing the mind and the soul of the pupils into relation with their surroundings in the same intimate manner as the study of the sciences does."

Stricken Formosa.—A severe earthquake rocked Formosa on the 21st April and is the worst in the Japanese territory since the disaster of 1923, when about a hundred thousand deaths were caused. As a result of the recent cataclysm two Provinces were devastated and four large towns were severely affected. Nearly three thousand persons are reported to have perished, about ten thousand houses collapsed and more than eleven thousand were damaged. The total loss to property is estimated to exceed 10,000,000 yen. Fortunately the sugarcane industry has been spared. An oilfield in the stricken area is reported to have rocked severely releasing a gusher which caught fire, adding terror to the inhabitants.

Stricken Formosa has evoked the sympathy of the nations and offers of help are forthcoming from the American Red Cross and other organisations.

Co-operation in Tea Research.—With a view to secure personal contacts between the staffs of the various Research Institutes devoted to Tea Research, Dr. R. V. Norris, Director, Tea Research Institute of Ceylon, with Mr. Forbes of the Planters' Association, Ceylon, will shortly proceed to Java, where they will have every opportunity to study the Research Organisations. They will be accompanied in the tour by Mr. Carpenter, the Director of the Tocklai Experimental Station, India. Arrangements have also been made for Mr. T. Eden, Agricultural Chemist, Tea Research Institute of Ceylon, to visit the Tocklai Station and for Mr. Cooper of the Tocklai Station to visit the Tea Research Institute of Ceylon.

The Kelvin Medal awarded by the Electrical Institute for outstanding Researches was presented to Sir Ambrose Fleming, the octogenarian inventor of the thermionic tube.

Professor L. Ruzicka of the Technische Hochschule, Zurich, will be a visiting Professor at the Department of Chemistry, University of Chicago, during the summer quarter beginning June 15th. The Professor will give two series of lectures: (1) Special topics in the chemistry of alicyclic compounds and terpenes and (2) Selected topics in Biochemistry.

According to a note appearing in "Chemical Age" the measures taken to eradicate malaria during 1931 as reviewed at a recent Moscow conference, include spraying from air craft over 600,000 hectares of marshland with Schweinfurt green and flooding 25,000 hectares with petroleum by the same means. 7,000 hectares of marshy ground have been drained. The Soviet Union has allocated 80 million roubles for fighting malaria in 1935. At the Conference, reference was made to the new synthetic anti-malarials, *Plasmozil* and *Akrichen*.

We have just received the Supplement to the *Journal of the Zoological Society*, Muslim University, Aligarh, India, dealing with the zoological laboratories, their equipment and staff. This is one of the many well-equipped teaching universities in India coaching students for the B.Sc. (Hons.), M.Sc. and Ph.D. courses. Besides lecturing work, the list of research papers given at the end of the supplement gives us to understand that the members of the staff are also pursuing original investigations in Helminthology and we do not very well agree with them when they say on page 2, that "This is the only university institution in India where research in Nematology in relation with the Tropical Diseases of Man and the Domestic animals is carried out." It is such a pity that the "Muslim community has not yet realised the value of research." This narrow-mindedness is not an exclusive monopoly of the Muslim community. It is largely prevalent elsewhere also. We hope that this limitation will soon disappear, and in building up the reputation of any department it is necessary to have a capable director inspiring an enthusiastic band of workers besides possessing a good library. We expect to see all this in the zoological laboratories of the Aligarh University.

The report on the Royal Botanic Gardens for 1933-34, which has been recently published, clearly points out the scientific and educational value for India of the Botanical Gardens. During the year considerable progress was made towards the enrichment of the Garden as a repository of the more useful and beautiful tropical and semitropical trees and shrubs. The garden of medicinal plants started sometime ago has been added to and renewed. Large exchanges with gardens abroad have been kept up. The requests for identification of specimens have been on the increase and the Royal Botanic Gardens have actively helped several institutions in starting reference herbariums. Thus, the School of Tropical Medicine, Calcutta, is building up a herbarium of medicinal plants with the help of the Royal Botanic Gardens and the Forest

Research Institute, Dehra Dun, received a collection of duplicate Malayan specimens. The report also mentions that a treatise on Indian Water plants intended primarily for distribution by the Malaria Survey of India for workers engaged in researches on the distribution of malaria carrying mosquitoes, is under preparation.

We acknowledge with thanks the receipt of the following:—

"Journal of Agricultural Research," Vol. 49, Nos. 10 and 11.

"The Journal of the Royal Society of Arts," Vol. 83, Nos. 4296-4300.

"Biochemical Journal," Vol. 29, No. 3, March 1935.

"American Journal of Botany," Vol. 22, No. 3, March 1935.

"The Journal of Institute of Brewing," Vol. 41 (Vol. 32, New Series), No. 4, April 1935.

"Canadian Journal of Research," Vol. 12, No. 3.

"The Chemical Age," Vol. 32, Nos. 821-825.

"The Journal of the Indian Chemical Society," Vol. 12, Nos. 2 and 3.

"Experimental Station Record," Vol. 72, No. 2.

"Forschungen und Fortschritte," Vol. 11, Nos. 10-12.

"The Quarterly Journal of Geological, Mining and Metallurgical Society of India," Vol. 7, No. 1, March 1935.

"Monthly Statistics of the Production of Certain Selected Industries of India," No. 9 of 1934-35, December 1934.

"Functions and Organisation of the Indian Meteorological Department," Government of India, Department of Industries and Labour, 1935.

"List of publications of the Institute of Plant

Industry—Leningrad, U.S.S.R.," for the year 1933.

"Report and Accounts of the Coconut Research Scheme for 1931," March 1935. Sessional Paper, Part 4, 1935.

"Coconut Research Scheme for 1933," April 1934, Sessional Paper, Part 5, 1934.

"Coconut Research Scheme for 1932," May 1933, Sessional Paper, Part 8, 1933.

"The Coconut Research Scheme, Ceylon," Bulletin No. 1, Report on the Soap Industry in Ceylon, November 1934.

Review of the activities of the Coconut Research Scheme of Ceylon," by Dr. R. Child (Reprint from the "Tropical Agriculturist," Vol. 83, No. 1, July 1934).

"Handbook of the Institute of Agricultural Research—Facilities of Study and Research," Benares Hindu University.

"Mathematics Student," Vol. 2, No. 4.

"Medico-Surgical Suggestions," Vol. 4, No. 4.

"Journal of the Indian Mathematical Society," Vol. 1, No. 4.

"Nature," Vol. 135, Nos. 3412-3416.

"Natural History," Vol. 35, No. 4, April 1935.

"The Journal of Nutrition," Vol. 9, Nos. 3 and 4.

"The Journal of Chemical Physics," Vol. 3, No. 4.

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"Research and Progress," Vol. I, No. 2, April 1935.

Inter-University Board, India—Annual Report 1934-35.

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The Spirit of Research.

IN an interesting address to the Fellows and Associates of the Institute of Chemistry at their Annual Meeting, Prof. J. F. Thorpe dealt with certain aspects of the profession of Chemistry both in academic life and in industry. (*Vide J. and Proc.*, 1935, Pt. II, p. 121.) Although these remarks were primarily intended for the chemists, they do nevertheless hold true for others as well; it appears therefore to be of importance to extract the relevant portions of the address.

These remarks relate to the application of team-work for the solution of important and urgent problems. This idea of team-work is the legacy of the Great German Schools led by Bensen, Victor Meyer, Fischer and others and in England by Perkin Jr. of recent memory. In all these instances, the individual was deeply engaged in one major problem with a number of research workers, while other questions of moment were also examined by him side by side. Thus, individualism marks out generally the man of superior merit and it is an innate quality which can neither be manufactured in the laboratory, nor its power be suppressed or hidden for long. Those who lack it, are mere workers under direction, however great their manipulative skill may be. Unless this quality is discovered and given free play, the force that directs other minds becomes dormant and rusty. In the present day,

team-work has lost this sense of expression of the individual and is replaced by grouping a number of workers, working for the state under some recognised leader. This feature is the resultant of war-time activities, when all brains and manipulative skill were harnessed by one, two or more powerful individuals, who co-operated among themselves. These were extraordinary circumstances.

Post-war conditions have not tended to modify the above system but extended it in a more virulent form—a feature which is the very essence of many Research Associations and industrial firms, resulting in or aiming at Mass Production. In consequence, individualism is not generally recognised resulting in necessarily killing craftsmanship. One of the chief aids to the development of individuality is indicated by the *impetus of acknowledgment and publication*. In order to encourage the workers in a team, it is quite essential to secure the publication of results under the names of the workers concerned which, many a time, is lost sight of by those above. By so doing, the individual worker feels confident, that he is capable of taking up other work, when the need arises for it.

How this capacity for the expression of the individual in a person can be detected, is a matter for serious consideration and is generally solved by

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the persons concerned, in the light of their experience. It is, however, significantly true that neither our modern system of education nor the training in the post-graduate course, provides adequate ground for such recognition. According to Prof. Thorpe, the institution of Ph.D. degree in several universities, represents one way of overcoming the defects. This method may be open to question, particularly when we consider that many universities have abolished or are considering the abolition of this degree. It is claimed that the three qualities—self-reliance, patience and initiative, so necessary to work of merit—are evinced by an average worker for the above degree. Men of experience may have a different tale to tell. Another defect, inherent to the selection of the proper individual lies in the fact that different universities have different standards in science training. In the case of higher degrees the institution of qualifying examination by the Institute of Chemistry, is of great benefit to the research worker in the making. In this way, he becomes a "qualified" chemist.

Speaking about the system of research control by committees, it has been said that it is also the outcome of the war and has continued even to-day. Given wide breadth of view and strong human sympathy on the part of the persons composing the committee, it is one of the best methods of solving some urgent problem, but in wrong hands, it is highly susceptible of destroy-

ing personal initiative and individuality. Team-work in such cases demands that there should be free discussion among the members of the team. It is, however, rather unfortunate that the members cannot individually claim personal merit for any discovery or work of outstanding merit, while the results of such investigations form the property of the whole team. The snag, in such cases, is that the humble worker does not get adequate recognition for his work, which is rightly due to him. On the other hand, if members of a team do not exchange notes or discuss freely for fear that some one else might get the credit for what is originally his, the benefits of co-operative effort are completely lost. It is a happy sign that this attitude is fast dying out. In fine, team-work requires suppression of the self of its component parts, in the interest of the team, while those in charge of the investigation or the employers, should scrupulously avoid suppressing individualism of these parts. In the words of General Smuts, "The disappearance of the sturdy, independent-minded, freedom-loving individual and his replacement by a servile standard of mass-mentality is the greatest menace of our time."

These timely remarks coming from such an eminent authority, it is hoped, will not be lost sight of in the development of scientific and industrial research in this country, which is yet on its path to recognition in the scientific world.

"CHEMIST."

Academies and Societies.

Indian Academy of Sciences.

April 1935. SECTION A. T. S. SUBBARAYA: *Analysis of the Band Spectrum of Zinc*.—The analysis of Hg , Cd and Zn bands given by the author removes many of the difficulties inherent in the previous explanation that each one of the band series is a single ν' progression. C. N. SRINIVASIENGAR: *Singular Solutions of Simultaneous Ordinary Differential Equations*. I. CHOWLA: *Some Problems of Waring's Type*. S. CHOWLA: *A Theorem on Sums of Powers with Applications to the Additive Theory of Numbers*. S. CHOWLA: *A Theorem on Sums of Powers with Applications to the Additive Theory of Numbers II*. T. SURYANARAYANA MURTY: *Note on Dirichlet's L-Functions*. D. S. SUBBARAMAIA: *On the Depolarisation of Tyndall Scattering in Colloids*.—The light incident on a system can be either unpolarised, or plane polarised with electric vector vertical, or plane polarised with electric vector horizontal. The inter-comparison of the corresponding values for depolarisation, p_u , p_v and p_h furnishes important information regarding the size and anisotropy of shape or structure of the scattering particles. R. S. KRISHNAN: *On the Depolarisation of Tyndall Scattering in Colloids*.—On the assumption that the law of distribution in direction of the orientation scattering by larger particles is the same as that for very small ellipsoidal particles, the following simple numerical relationship $p_u = (1 + 1/p_h)(1 + 1/p_v)$ has been derived and found to be in satisfactory agreement with the observations reported in the previous paper. R. SAMUEL AND M. ZAKI-UD-DIN: *Note*

on the Absorption Spectrum of CaI.—The end absorption in the ultra-violet is the only real absorption of CaI molecule. There are no bands present. S. K. BANERJI: *Theory of Microseisms*.—Microseisms of a definite type are produced by the disturbance of pressure at the bed of the sea produced by storm waves in the mid-Arabian Sea and mid-Bay of Bengal. A theory of these microseisms has been worked out by introducing into the usual hydrodynamical equations terms involving compressibility, and the amplified theory gives a satisfactory explanation of all the observed facts. Various other causes which might also produce microseisms are discussed. AKSHAYANANDA BOSE: *The Weiss Constant of Paramagnetic Ions in the S-State. Part II. Aqueous Solutions of Ferric Salts*.—The product χT for aqueous solutions of ferric salts is appreciably less than the theoretical value. A study of these deviations, with respect to nature and concentration of salt, the acid content, and the temperature, indicates that the deviations might be due to the hydrolysis of the salts.

SECTION B. M. K. SUBRAMANIAM: *Preliminary Observations on the Effect of Fertilization on the Golgi bodies in the eggs of Acentrogobius neilli (Gobius neilli, Day)*.—On fertilisation the golgi elements below the zona enlarge and the rim of the fatty yolk droplets break up into irregular granules; concurrent with these changes the inner portions of the zona become converted into a mucilaginous envelope, after the completion of which, the majority of the golgi are extruded. H. CHAUDHURI: *A Bacterial Disease of Wheat in the Punjab*.—By means of successful inoculation

experiments, it has been shown that the bacterial disease previously described by Hutchinson (1917), is caused by the bacteria *Ps. tritici* alone and that the presence of nematodes—*Tylenchus scandens* which were once suspected to play a part in the causation of the disease, is not necessary. P. MAHESHWARI: *Contributions to the Morphology of Ephedra foliata*, Boiss. I. The development of the male and female gametophytes.—A detailed account is given and forms the first of a series of papers concerning the complete life-history and anatomy of this species. A. SREENIVASAN: *Investigations on the Role of Silicon in Plant Nutrition. Part I. On the nature of interaction between soil and soluble silicates.*—The interaction between soil and silica, resulting in the retention of a large quantity by the soil (55-81 per cent.) is mainly due to adsorption. K. M. GUPTA: *A review of the Genus Dipterocarpoxyton of Holden with Description of a New Species D. Holdenii from the Irrawaddy system of Burma.*—A review of the work on *Dipterocarpoxyton* since 1916 has been given. B. M. JOHRI: *The Gametophytes of Berberis nepalensis Spreng.*—From the morphological study, it is concluded that the *Berberidaceae* shows a close relationship with the *Ranunculaceae* and both should be included in the same group. A. RAMAKRISHNA REDDY: *The Structure, Mechanism and Development of the Gastric Armature in Stomatopoda with a Discussion as to its Evolution in Decapoda.*—An account of the structure and the *modus operandi* of the gastric armature of *Squilla nepa*, Latreille, in the light of the development of its oral and thoracic appendages, is given.

Indian Chemical Society.

February 1935. N. R. DHAR, SANT PRASAD TANDON AND S. K. MUKHERJI: *Denitrification in Sunlight and its Retardation*. KALIPADA BASU AND RAMAKANTA CHAKRAVARTI: *Action of Dyestuffs and Narcotics on Proteolytic Enzymes—Trypsin and Pepsin*. G. V. JADHAV AND Y. I. RANGWALA: *Bromination of Substances containing two Aromatic Nuclei.*—Part I. Bromination of Cresyl and Nitro-

phenyl Benzoates. PRAFULLA CHANDRA RAY, HARI CHANDRA GOSWAMI AND ANIL CHANDRA RAY: *On the Fluorination of Organic Compounds.*—Part I. NIL RATAN DHAR: *Chemical Aspects of Biological Oxidation*. P. G. DESAI AND A. M. CHATEL: *Effect of Polarity on the Solubilities of Some Organic Acids*. B. K. CHATTERJEE AND B. L. VAISHYA: *The Reaction between Iodine and Oxalic Acids in Ethylene Glycol as a Solvent (A Preliminary Note)*. DUKKHAHARAN CHAKRAVARTI: *Mercuration of Cumariis (A Note)*. BIMAN BIHARI DAY, RUBI GUNDAY HARI RAMACHANDRA RAO AND TIRUVENKATA RAJENDRA SESHADRI: *Geometrical Inversion in Acids derived from Coumarins*.

March 1935. ABANI K. BHATTACHARYA: *Composition of Prussian and Turnbull's Blues, Part III*. N. R. DHAR, A. K. BHATTACHARYA AND B. L. MUKHERJI: *Photochemical Reactions between Iodine and Oxalate*. GADIYARA GUNDU RAO: *The Dissociation Constant of Eugenol*. M. P. VENKATARAMA IYER: *Adsorption Indicator in the Volumetric Estimation of Sulphates.*—A Colloido-Chemical Study. PULIN BEHARI SARKAR: *The Chemistry of Lute-lignin. Part VI. Isolated Lignin and Lignin Natives in Lute*. D. S. NARAYANAMURTI: *A Note on the Photochemical Reaction between Ethylene Iodide and Iodine in Carbon Tetrachloride Solution*. JNANENDRANATH MUKHERJEE, RAMPRASAD MITRA AND ANIL KUMAR BHATTACHARYA: *On the Measurement of Absolute Rates of Migration of Ions by the Method of Moving Boundaries*. PRIYADARAJAN RAY AND DINES CHANDRA SEN: *Magnetic Susceptibilities of Cobaltic Salts and the Nature of the Cobaltic Ion*. S. P. GOVEL AND B. L. VAISHYA: *The Complex Formation between Manganese or Aluminium with Tartaric Acid in Alkaline Medium*. R. PADMANABHAN: *A Simple Apparatus for Fractional Solidification*. PARES CHANDRA BANERJEE: *Use of Vanadous Sulphate as a Reducing Agent. Part I*. M. B. RANE AND K. R. APTE: *Volumetric Estimation of Chlorides and Sulphates in a Mixture containing both with the help of Adsorption Indicator*.

XII International Congress of Zoology.

THE XII International Congress of Zoology will be held in Lisbon on 15-21 September of this year, under the presidency of Prof. Dr. A. Ricardo Jorge, Director of the Faculty of Sciences in the University of Lisbon. His Excellency the President of the Republic, Marshall Carmona and the Minister of Public Instruction are patrons of the Congress.

The sections of the Congress are the following: General Zoology, Experimental Embryology and Mechanism of the Development, Ecology, Zoogeography, Paleozoology, Comparative Anatomy, Comparative Physiology, Protistology, Entomology, Invertebrates, Vertebrates, Zootechnic,

Bachiculture, Symbiosis and Parasitism, Nomenclature.

The Indian Universities have been officially invited to participate in the Congress and it is expected in the scientific centres in Portugal that an Indian delegation will be sent to Lisbon to represent the Indian Zoologists.

The social part of the Congress is most interesting; moreover the official dinners and receptions, a visit to the principal historical monuments of Portugal, a visit to the three University towns (Lisbon, Coimbra, Oporto) and a sea trip to the Archipelago of Azores and the Island of Madeira are included in the programme.

Reviews.

MODERN SURVEYING FOR CIVIL ENGINEERS.
By Harold Frank Birchall, O.B.E., D.F.C., ETC.
(Chapman & Hall, Ltd., London). Pp. 524.
Price 25s.

This book on surveying for Civil Engineers is the outcome of the author's experience in engineering surveys and is written with the purpose of placing in the hands of the engineer—specially the younger practitioner of the profession—a volume to enable him to get an insight into the practical side of surveying—that most valuable part of an engineer's work generally inadequately or not at all treated in most text-books.

The author presents the fundamental principles of surveying in a simple and clear style, eschewing almost rigorously all that he considers extraneous and superfluous matter. His treatment, though concise, is comprehensive and the great merit of the book consists in the lucid exposition of the methods of surveying as actually employed in connection with the several engineering projects. The young engineer, when faced with a problem, is sure to find a guidance in the pages of this book where detailed accounts of procedure adopted in solving similar problems encountered elsewhere in the past, are succinctly and lucidly given. The methods of estimating the cost of conducting surveys and determining the requirements under each head are other special features of this book.

The first eight chapters deal with the measurement of distances, accurate base line measurements for bridge location, methods of levelling, different types of levelling instruments, angular measurements by compass and theodolite, detailed descriptions of improved types of theodolites such as the micrometer and the *Wild* and *Tavistock* theodolites and Tacheometry including a discussion on the relative merits of the Jeffcott's Beaman's, Watts-Szepessy and Boss-Hardt Zeiss Reduction Tacheometers. The next three chapters deal with the methods of cross sectioning, contouring, traversing and descriptions of the plane-table and the range-finder and methods of using them. The succeeding six chapters are mainly devoted to the methods adopted in connection with irrigation, pipe-line, water-supply, road and railway project-surveys including tidal-flow surveys for sewage disposal and tunnel-surveying. There is a chapter on circular and transition curves and

another on railway Points and Crossings. The last two chapters deal with photographic and aerial surveying, just to give the reader the bare elements involved in such surveys and enable him to appreciate their applicability in specific cases, and localities, in preference to the ordinary ground methods.

The book is well-written and a large amount of new material, specially regarding recent improvements in surveying instruments, not to be found in many of the existing text-books, is included. Particular attention is called at all stages to the accuracy attainable in the different methods of surveying and the need for and methods of saving the needless labour and time generally spent on the attainment of the highest possible accuracy, whether necessary or not. The author's close association with surveying schemes is undoubtedly responsible for the many practical tips and the short and direct methods of approach to problems, that the book abounds in. There are numerous well-drawn diagrams besides several photographs of representative modern surveying instruments which will help the reader to follow the text with ease.

The aim of the author to place in the hands of the engineer a handbook of practical surveying, which will be of real help in solving field problems, is amply achieved and the book will be a very desirable addition to the reference library of an engineer.

D. SUBBA RAO.

* * *

CELLULAR RESPIRATION. By Norman U. Meldrum. (Mathuen's monographs on biological subjects) 1933. Pp. xi+116. Mathuen & Co., Ltd., London. Price 3 sh. 6 d.

The book prepared by the late Dr. Meldrum sets forth in a simple manner and in a short compass the salient features of cellular respiration the literature on which is highly confusing, particularly for the beginner. The subject by itself forms a very important branch of biochemistry; in recent years, its importance has increased, as its ramifications have extended beyond simple 'respiration'. Thus oxidations and reductions play an important rôle in the activation of proteases; glutathione appears to function as a co-enzyme for glyoxalase, and is thus connected with carbohydrate metabolism.

Dr. Meldrum's treatment is logical and is easily understandable by the beginner. The

method of the book represents what may be described as "loud thinking". Its brevity has no doubt restricted its scope. The inclusion of a few essential experimental details would have greatly enhanced the value of the book; the 3-page appendix hardly serves the purpose. A few aspects of the subject could have been elaborated with advantage. Thus the close relationship and perhaps identity between the "Atmungs ferment" and "Indophenol oxidase" should have been emphasised. In the chapter on dehydrogenases, the products of oxidation of the metabolites could have been fully described. The chemical configuration of methylene blue has been needlessly repeated and in other respects too, such as in the arrangement of matter, the book is capable of improvement. There is no doubt, however, that the book forms an excellent introduction to the subject and even for the student requiring access to original literature a very useful list of selected references is given at the end of each chapter.

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HANDBOOK OF CHEMISTRY. Compiled and Edited by N. A. Lange. (Handbook Publishers, Inc. Sandusky, Ohio,) 1934. Pp. 1265 + 249 + 29. Price \$6.00.

This handbook compiled and edited by Dr. Lange will be welcomed by all chemists who require a reference volume containing "Chemical and physical data used in laboratory work and manufacturing." The list of contents comprise nearly 160 different sections compiled with specific attention to their utility for those interested in Chemistry and allied sciences. The comprehensive nature of the different sections can be appreciated when it is mentioned that under "Physical constants of organic compounds" there are 4452 entries with their Beilstein references. There can be little hesitation in saying that this book will prove indispensable to every worker having difficult access to a technical library.

The volume will find a place on the desk rather than on the book-shelf, as there is little doubt that the Chemist will find need to turn to its pages for frequent reference. By reason of the fact that the Editor has obtained valuable assistance and co-operation of a very large number of competent chemists in his arduous task, the handbook bears the stamp of an authoritative and reliable document. The get-up of the book with its flexible binding leaves nothing to be desired.

* * *

STUDIES IN THE PHYSIOLOGY OF THE EYE. By J. G. Byrne. (Messrs. H. K. Lewis & Co.) Pp. 428. Price 40s.

"The title is somewhat misleading as the book is entirely devoted to certain limited aspects of ocular physiology and does not attempt to traverse the whole field of the subject usually termed "Physiology of the Eye". If the extent covered is small, the thoroughness with which the studies are made more than compensate what might appear at first a narrow field. Every chapter in the book bears ample evidence of numerous very careful and scientifically controlled Laboratory animal experiments from which conclusions have been drawn. The book is a valuable example of what good scientific reliable Laboratory work should be; for every batch of experiments are given the main purpose, the methods employed, experiments made, observations noted and conclusions drawn. Apparent discrepancies are not ignored but critically examined and where possible fully explained.

The book is divided into four parts. The first part deals with paradoxical papillary phenomena following lesions of the afferent nerve paths. The author concludes that various somatic lesions and various visceral lesions produce an inequality of the pupils which fact considered in conjunction with somatic pain direct or referred will be of great value in diagnosis of disease and in medicolegal work. Part II deals with "Preliminary palpebral widening" with light stimulus and paradoxical palpebral and lens phenomena. Part III gives the results of stimulation of the sciatic nerve, the cervical sympathetic and VI cranial nerves and the observations made regarding palpebral widening or narrowing, proptosis or retraction of eye-ball and allied phenomena. Part IV deals with pupil constrictor tonus and the mechanism of sleep, hibernation, Narcosis, Coma and related conditions. The rôle of the pupil constrictor tonus in such pathological states as Argyll-Robertson pupil, anisocoria and miosis is dealt with. There is a critical discussion regarding the causation and the essential ingredients of the phenomenon of sleep in man and higher animals and conditions analogous to sleep in many lower animals as fish, frogs, reptiles and insects.

There is much that is rather unorthodox and thought-provoking in most of the chapters each of which has a rich Bibliography. The whole book is well illustrated and

provided with a good index. The work is of great value to Physiologists and Neurologists.

B. K. N.

STRUCTURAL GEOLOGY—WITH SPECIAL REFERENCE TO ECONOMIC DEPOSITS. By Bohuslav Stoces and Charles Henry White. (Macmillan & Co., 1935). Price 25s. net.

This book is an elaboration of the work by Dr. Stoces on this subject (which has already been published in Czech and German) in collaboration with Mr. C. H. White, former Professor of Mining and Metallurgy at Harvard University and now a consulting mining geologist with considerable experience in many parts of the United States and in several European countries. The book is primarily intended to meet the requirements of economic geologists and mining engineers engaged in the exploitation of mineral deposits. Being thus essentially a text-book of applied geology, special emphasis is naturally laid only on such aspects of structural geology as are necessary for those engaged in the successful exploitation and development of ore bodies. The first part of the book deals with the primary structures of rocks, both igneous and sedimentary, as distinguished from the induced or secondary structures in these rocks due to orogenic movements in the earth's crust, which have been elaborately described in the second part. At the end of each section a convenient summary of all the important conclusions has been given, often regularly tabulated, as for instance, in describing the damaging and beneficial effects of Faulting (pp. 246-260). Towards the end of the book there is just a small chapter of about 16 pages dealing with geophysical methods of prospecting, with special reference to those methods which have been successfully employed in recent years, based on such considerations as magnetism, gravity, rock elasticity, electrical conductivity, radioactivity, etc. The book is profusely illustrated with diagrams, sections and photographs (in fact, these make up nearly half the volume of the book) mostly taken from such standard works of continental authors as Schaffer's *Allgemeine Geologie*, Weissenack's *Allgemeine Petrographie*, Rinne's *Gesteinskunde*, Heim's *Geologie der Schweiz*, etc.

There are just a few points, however, on which one feels inclined to comment after perusing the book. In some places, as for

instance in the very first chapter on the Primary Structure and Arrangement of Sedimentary Rocks, the treatment of the subject-matter seems to be rather digressive; and although nothing has been said which is not useful, one feels that there is a certain amount of "rambling". The chapters on Joints and Veins might, probably with great advantage, have come before those on Folding and Faulting. This arrangement would also have secured the necessary continuity in thought between the chapters on Folding and Faulting and the next one on the "Principal Types of Structures in Folded and Faulted Regions". In dealing with the "nomenclature of faulting" (p. 180) the author says: "Since no system thus far proposed has had general acceptance we have, for the sake of simplicity and clearness, endeavoured to define precisely those terms in the use of which there has been lack of agreement." On going through the next few pages, we are not sure if the authors have succeeded in this endeavour to combine the three great virtues of simplicity, clearness and precision, in their own definitions.

Most of these points raised for comment and criticism may perhaps be considered as merely matters of opinion. Probably they are. In any case they do not seriously affect the value of the book which will be read with great profit by all those technical men who are interested in the development and exploitation of useful mineral deposits.

L. RAMA RAU.

ACTUALITES SCIENTIFIQUES ET INDUSTRIELLES. No. 199. RADIOACTIVITE ARTIFICIELLE. By F. Joliot and Irène Curie. Paris, Hermann et Cie. 1935. Price 10 fr.

This monograph on the new and fast-developing field of "Artificial Radioactivity" by the original discoverers of new and artificially produced radioactive elements is a most opportune and authoritative exposition of the results so far obtained in this rich province of research. A full account of the fundamental experiments of the authors is given and then a brief discussion of the results of other observers. One could have wished for a more complete account of the results obtained by Fermi and his collaborators. Though the authors have been compelled to add a footnote that Fermi's claim concerning the production of elements beyond Uranium is disputed, the more recent work of Meitner seems to testify to the actuality of the production of elements 93 and 94. The

monograph hints at the immense possibilities that may materialise by the use of the artificially produced radio-elements in therapy and biological research. As a precursor in such a promising field, the present work will meet with a warm reception from all quarters. We must congratulate the Publishers on securing such timely and authoritative expositions of the most up-to-date results of modern research.

T. S. S.

LE MOMENT ELECTRIQUE EN CHIMIE ET EN PHYSIQUE. GENERALITES ET METHODES. By J. Errera. (Hermann et Cie, Paris, 1935). Pp. 46. 14 Fr.

LE MOMENT ELECTRIQUE EN CHIMIE ET EN PHYSIQUE. MOMENT ELECTRIQUE ET STRUCTURE MOLECULAIRE. By J. Errera. (Hermann et Cie, Paris, 1935). Pp. 59. 15 Fr.

In these two monographs in the *Actualités Scientifiques et Industrielles* series the author has presented an extremely lucid and concise account of the present state of knowledge on the subject of dipole moments in chemistry and in physics. The first monograph is divided into three chapters, dealing respectively with a general account of polarisation and dispersion, methods of determining electric moments, and the theory of atomic bindings. This last chapter on homopolar and heteropolar bonds, valency angles, mobility of bonds and quantum resonance will be found to be particularly illuminating for many chemists not usually acquainted with the recent theories of molecular physics. The second monograph gives a neatly classified account of the informations gained regarding the structure of molecules, both organic and inorganic, from a study of their dipole moments.

The exposition is throughout supported by bold diagrams, clear tables, and a number of references to original papers. There is but one misprint, an obvious interchange between the moment values for nitro and nitroso benzene in table 8A, p. 17 of the second volume. In the midst of a number of books and monographs recently published on the subject of dipole moments, we have no hesitation in saying that these two *exposés* will be found useful both by physicists and by chemists.

M. A. G.

DIFFRACTION DES RAYONS CATHODIQUES PAR. By G. P. Thomson. (Hermann et Cie, Paris.)

This monograph is published as a part of

Actualités Scientifiques et Industrielles in the section on theoretical physics under the direction of M. Louis de Broglie. It consists of translations in French of the first three papers on Electron Diffraction by G. P. Thomson published in the *Proceedings of the Royal Society*. The pioneer investigations dealt with in these papers are of historic value. They were the first experiments that were performed to demonstrate the wave nature of the electron. The diffraction of electrons now offers a powerful tool for the study of surface structure, the structure of free molecules and other topics. The above monograph on the pioneer investigations in these lines will be welcomed by workers in this field.

S. R.

RECHERCHES SUR LES COMBINAISONS ENTRE LES SELS DE CALCIUM ET LES ALUMINATES DE CALCIUM. By J. Foret. (*Actualités Scientifiques et Industrielles*, 1935.)

The first 12 pages of this paper are devoted to a historical account of the subject and bring under review the existing knowledge about the various aluminates of calcium including those which contain sulfo and chloro groups.

The original investigations described in this paper establish the formation of two types of aluminates having the formulae (I) and (II), when tricalcium aluminate reacts with soluble salts of calcium.

I. $3 \text{ CaO} \cdot \text{Al}_2\text{O}_3 \cdot (\text{A})_2\text{Ca} \cdot 10 \text{ H}_2\text{O}$.

II. $3 \text{ CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3(\text{A})_2\text{Ca} \cdot 30 \text{ H}_2\text{O}$,

where A represents Cl, Br, I, (NO_3) , or (NO_2) .

The characteristics of these compounds were studied with a microscope as well as by X-ray methods.

Adequate evidence is given to prove that tetracalcium aluminate is hexagonal, whereas tricalcium aluminate is cubic in structure.

The paper includes 4 excellent plates which show the Debye-Scherrer diagrams and microphotographs of some of the compounds investigated.

K. R. K.

HOST PLANT INDEX OF INDO-CEYLONESE COCCIDÆ. By S. Ramachandran and T. V. Ramakrishna Ayyar. (*Misc. Bull.* No. 4, Imp. Council Agr. Res., Delhi, 1934.) Price Rs. 1-10-0.

Its modest price and clear printing would give this publication a wide circulation both in India and outside it; but it is not comparable in quality with similar publications

in Europe and in America. The compilers show a lack of first-hand information with the insects mentioned and have not exhausted all the literature available. The names of plants are further arranged, at the end, in an alphabetical order while a similar index giving the names of insects would have been even more useful. In its absence it took us some time to realise that no new insect has been named by the compilers from Coimbatore nor by any worker from Pusa or Ranchi, three Indian centres, where so much work has been done on scale insects. The student of ecology would regret to find many plants not specifically mentioned and as such these items serve as mere decorations. For example, on the first page *Tachardina lobata* is mentioned attacking *Michelia champaca* and again another *Michelia* sp. which is highly improbable. At least the mistake regarding *Laccifer lacca* which is said to attack a *Schleichera* sp. besides *S. trijuga* could have been avoided by reference to the publications of Watt and of Glover, not mentioned in the bibliography, which would have added many more hosts to the list given in the publication under review. There are many such instances of double entry which only lead to confusion. *Laccifer mysorensis* is mentioned as found in India which would imply a wide range of distribution while as its name implies it is restricted to Mysore and the British districts adjoining it. *L. lacca* Kerr is stated also to attack *Shorea talura* which many a worker in Bangalore has shown not to be the case. *T. lobata* is supposed to have been named by Chamberlain. He spells his name as Chamberlin and Cockerell (*Psyche*, 1924, 31, 47) has pointed out it should be credited to Green and Chamberlin has accepted it (*Bull. Ent. Res.*, 1925, 16, 41). *Metacardia* is wrongly spelled at least in three places for *Metatachardia*. The name *Beesonina dipterocarpi*, Green (*Bull. Ent. Res.*, 1929, 19, 205) is nowhere mentioned nor the bibliography gives Green's publications later than 1926-27, although the Bulletin was accepted for publication as late as 1932. *Inglisia chelonioides* is not cogenetic with *I. bicalvata*; the latter belongs to the genus *Cardiococcus* (*J. Bom. Nat. Hist. Soc.*, 28, 4, 1034). *Lecanium colemani* Kann. is a very doubtful species questioned by Green and its non-existence, even in Bangalore, has already been shown. On p. 52 *T. Silvestrii* is given, without reference to any literature or locality, as attacking an

Ixora sp. while its name is absent from the parasites of *Ixora coccinea*, a mistake which could have been easily avoided by consulting the necessary publication.

S. M.

REVIEW OF CURRENT LITERATURE RELATING TO PAINT, COLOUR AND VARNISH INDUSTRIES, Jan.-Feb. 1935. Pp. 82. (Research Association of British Paint, Colour and Varnish Manufacturers, Teddington.)

This 82-page volume introduces the reader to the rapid progress made in the various branches of paint, colour and varnish research and every progressive manufacturer in the trade will not fail to appreciate the importance of a review of this kind offered by the Research Association of British paint, colour and varnish manufacturers—a prosperous organisation which is rendering great services to the advancement of the paint industry in Great Britain. A particularly refreshing feature of the review is the importance given to shellac by devoting a special section to record the researches done on this important natural product now struggling to re-establish its pre-eminence. This review will be gratefully welcomed by every one interested either in research or manufacture of paints, colours or varnishes.

M. S.

LAC AND THE INDIAN LAC RESEARCH INSTITUTE. By Dorothy Norris, M.Sc., F.I.C., P. M. Glover, B.Sc., and R. W. Aldis, Ph.D., D.I.C. (Criterion Printing Works, Calcutta, 1934). Pp. 53. Price Rs. 2-8-0.

The volume aims at giving those interested in the industry from whatever point of view, a concise and non-technical summary of the position when the Institute began its work, and of the results obtained of value to the industry during the last nine years of its activity. The brief summary of the Indian Lac Industry prefacing the volume refers to the pioneering entomological investigations of Tachard, Kerr, Carter, Stebbing, Imms and Chatterjee and Misra. It is unfortunate that there is no reference to the extensive entomological studies of Mahdihassan who was one of the first to establish the trivoltine character of a race of lac insects indigenous to the Mysore plateau. He has been the first to recognise the importance of various races of lac insects in relation to the quality of their lac secretion, a fact of great technical importance.

One wonders if the value of the publication would have suffered if attention had been called to the work of the Indian Institute of Science during the years 1917-1927, for a full period of 10 years during the time of Professors Fowler and Norris. It is difficult to deny that the foundations of biochemical and technological research on lac were laid at the Indian Institute of Science at Bangalore, and the circumstance that all the assistants in the physico-chemical and biochemical sections of the Namkum Institute are men trained at the Institute, bears ample testimony to this fact.

This unfortunate omission of a substantial portion of the recent work on the biochemical, entomological and technological aspects of lac carried out in a sister institution, lends a propagandist touch to the publication.

It would have been of some assistance to the interested public if a financial statement of the Institute were appended to the report. It is difficult to assess the value of fundamental research but where research is definitely meant to assist an industry, the public are taught to estimate the value of research in terms of the increased prosperity or stability which research may bring to the industry.

The revenue from the Lac cess levied by the Government of India amounts to nearly two lakhs a year and the aggregate amount spent on the founding and maintaining the Lac Research Institute at Namkum during the last 10 years, might now exceed twenty lakhs (precise figures are not available). The volume concludes with an impressive array of 88 publications issued from the Institute which we propose reviewing on a future occasion.

M. S.

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REPORT ON THE SOAP INDUSTRY IN CEYLON. (BULLETIN No. 1, COCOANUT RESEARCH SCHEME, CEYLON. By R. Child, F.I.C., B.Sc., Ph.D. (Lond.))

This is the first of a series of bulletins issued by the board of management of the Cocoanut Research Scheme of Ceylon. As the Chairman points out in his introduction "This review of local raw materials that can be used in the manufacture of soap, of soap making process generally and of

suggestions helpful to the local industry, comes at an opportune time and from one who has a knowledge of the technology of the industry."

The author commences his report with a critical and exhaustive examination of the various raw materials used for soap manufacture and proceeds to discuss the several soap-making processes now in vogue everywhere. An account of the chemistry of oils and fats is given in a manner, that should appeal itself even to the soap manufacturer who had not had the benefit of a systematic chemical training. Next a fairly detailed examination is made of the local raw materials available with special reference to the different varieties of cocoanut oil.

In discussing the different soap-making processes, the author dwells at length on the *Cold Process*, as the majority of soaps made in Ceylon at present are by this process according to him. Minute practical details are given and this should be of immense benefit particularly to the untrained soap maker. A brief account of the semi-boiled and settled processes of soap-making is also given.

In his recommendations, Dr. Child observes:—

".... the local industry is quite capable of producing cheaply a reasonably good household soap in sufficient quantities. As an encouragement to develop a moderate increase in import duties would probably have good effect; ...The local industry is not in a position to compete in the toilet-soap industry at present and 'prohibitive' increases in tariff are undesirable for that reason. An increase of 5 p.c. on all tariffs would not seem unreasonable"

Apart from this he suggests the establishment of a Government factory on the model of the Government Soap Factory, Bangalore, and a bureau of chemical advice. There is also a suggestion to control the quality of the soap by the Government by the issue of labels. These are recommendations worthy of serious consideration by the Government.

The report as a whole should commend itself to everyone engaged in the soap industry, directly or indirectly. The board of management of the Cocoanut Research Scheme deserves the thanks of the public for having decided to issue this valuable report gratis to all.

M. S. KRISHNA RAO.

Erratum.

Vol. III, No. 10, p. 493, column 2, para 2, line 4,
For *Ophecephalus stolatus*, read '*Tropidonotus stolatus*'.

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